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ORIGINAL MEMOIRS.

FRACTURE OF THE SPINE.¹

A SUMMARY OF ALL THE CASES (244) WHICH WERE TREATED
AT THE BOSTON CITY HOSPITAL FROM 1864 TO 1905.

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Is the spinal cord irremediably damaged? This is the question that immediately arises in the mind of a surgeon when he first sees a patient with a fracture of the spine. The utter hopelessness of the condition, when there is complete destruction of the cord, is universally accepted.

Can we tell whether a spinal cord is irremediably damaged or not? On the answer to this question depends in many cases whether or not an operation should be done.

In many cases it is perfectly clear that the cord is crushed. In other cases doubt exists as to whether the cord is irremediably damaged. In still other cases it is a fair presumption that the cord is not hopelessly damaged.

These questions are constantly presenting themselves to surgeons, and it is often impossible to answer them dogmatically in an individual case.

Prior to 1887 the expectant treatment of fractures of the spine was practically always used. The mortality was so

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large, and the suffering so distressing, that it led me to advocate immediate rectification of the spine and its fixation by a plaster-of-Paris jacket.¹

Open operations on the spine have been done occasionally since Henry Cline operated at St. Thomas's Hospital in 1814, but all these operations were futile or followed by a fatal ending.

Antisepsis and a simple method of doing laminectomy have rendered it possible to open the spinal canal and to look at the cord. An open operation gives definite information as to the condition of the cord, and above all allows pressure to be removed in some cases. Naturally an open operation quickly superseded immediate rectification, which was at best a "hit or miss" method of relieving pressure on the cord.

The largest collection of fractures of the spine was made by Gurlt,² who reported 270 cases. Thorburn's³ well-known work is of great value. Morton⁴ considered the subject carefully. Lloyd⁵ presented 227 cases and judiciously summarized the subject.

The writer has twice reported the fractures of the spine at the Boston City Hospital, through the courtesy of his colleagues. The first series (82 cases) was published in the *Medical Communications of the Massachusetts Medical Society*, vol. xiv, No. 1, 1887, p. 151. The second series (168 cases, which included the first series of 82 cases) was presented to the British Medical Society in August, 1894, and abstracts of the paper were published in the *Medical Press and Circular*, London, August 29, 1894, in the *British Medical Journal*, August, 1894, and in the *ANNALS OF SURGERY*, February, 1895.

The writer now presents a third series of 244 cases, which includes the two previous series. The details of the 244 cases are not presented, but a summary of the three series of cases is given, and a comparison of the different series is interesting and instructive.

These tables show the frequency of symptoms; the deaths and recoveries in the different regions; the mortality; the

duration of life in the fatal cases; and the results as to whether the patient is useful or useless in the recoveries.

FIRST SERIES.—1864-1887.

Frequency of Symptoms.—Total cases, 82. Crepitus, 51, 62.1 per cent.; deformity, 63, 76.8 per cent.; unconsciousness, 18, 21.9 per cent.; paralysis, complete, 67, 81.7 per cent.; paralysis, incomplete, 6, 7.3 per cent.; paralysis, none, 9, 11 per cent.; pain, 71, 86.5 per cent.; priapism, 18, 21.9 per cent.; delirium, 12, 14.6 per cent.; cystitis, 31, 37.8 per cent.; bed-sores, 27, 32.9 per cent.

Regions.—Total cases, 82. Cervical, 28, 34.1 per cent. Deaths, 25, 89.2 per cent.; recoveries, 3, 10.8 per cent. Upper dorsal, 12, 14.6 per cent. Deaths, 8, 66.6 per cent.; recoveries, 4, 33.4 per cent. Lower dorsal, 19, 23.1 per cent. Deaths, 18, 94.7 per cent.; recoveries, 1, 5.3 per cent. Lumbar, 23, 28.0 per cent. Deaths, 13, 56.5 per cent.; recoveries, 10, 43.5 per cent.

Mortality.—Total cases, 82. Deaths, 64, 78 per cent.; recoveries, 18, 22 per cent.

Time.—Total cases, 82. Total deaths, 64, 78.0 per cent. Within 5 days, 39, 60.9 per cent.; within 10 days, 8, 12.6 per cent.; within 1 month, 7, 10.9 per cent.; after 1 month, 10, 15.6 per cent.

Results.—Total cases, 82. Total recoveries, 18, 22 per cent. Useful, 9, 50 per cent.; useless, 9, 50 per cent.

SECOND SERIES.—1887-1900.

Frequency of Symptoms.—Total cases, 114. Crepitus, 30, 26.3 per cent.; deformity, 58, 50.8 per cent.; unconsciousness, 14, 12.2 per cent.; paralysis, complete, 93, 81.5 per cent.; paralysis, partial, 14, 12.2 per cent.; paralysis, none, 7, 5.1 per cent.; pain, 58, 50.8 per cent.; priapism, 37, 32.4 per cent. (106 male cases); delirium, 29, 25.4 per cent.; cystitis, 22, 19.3 per cent.; bed-sores, 23, 20.1 per cent.

Regions.—Total cases, 114. Cervical, 44, 38.5 per cent.

Deaths, 41, 93.1 per cent.; recoveries, 3, 6.9 per cent. Upper dorsal, 24, 21.0 per cent. Deaths, 22, 91.6 per cent.; recoveries, 2, 8.4 per cent. Lower dorsal, 34, 29.8 per cent. Deaths, 19, 55.8 per cent.; recoveries, 15, 44.2 per cent. Lumbar, 12, 10.5 per cent. Deaths, 7, 58.3 per cent.; recoveries, 5, 41.7 per cent.

Mortality.—Total cases, 114. Deaths, 89, 78 per cent.; recoveries, 25, 22 per cent.

Time.—Total cases, 114. Total deaths, 89, 78 per cent. Within 5 days, 67, 75.2 per cent.; within 10 days, 7, 7.8 per cent.; within 1 month, 8, 9.2 per cent.; after 1 month, 7, 7.8 per cent.

Results.—Total cases, 114. Total recoveries, 25, 22 per cent. Useful, 15, 60 per cent.; useless, 10, 40 per cent.

THIRD SERIES.—1900-1904.

Frequency of Symptoms.—Total cases, 48. Crepitus, 12, 25 per cent.; deformity, 37, 77 per cent.; unconsciousness, 9, 18.7 per cent.; paralysis, complete, 25, 52.0 per cent.; paralysis, partial, 7, 14.5 per cent.; paralysis, none, 16, 33.3 per cent.; pain, 42, 87.5 per cent.; priapism, 11, 23.9 per cent. (46 male cases); delirium, 2, 4.1 per cent.; cystitis, 13, 27.0 per cent.; bed-sores, 13, 27.0 per cent.

Regions.—Total cases, 48. Cervical, 14, 29.1 per cent. Deaths, 11, 78.5 per cent.; recoveries, 3, 21.5 per cent. Upper dorsal, 7, 14.5 per cent. Deaths, 3, 42.8 per cent.; recoveries, 4, 57.2 per cent. Lower dorsal, 22, 45.8 per cent. Deaths, 4, 18.1 per cent.; recoveries, 18, 81.9 per cent. Lumbar, 5, 10.4 per cent. Deaths, 0; recoveries, 5, 100 per cent.

Mortality.—Total cases, 48. Deaths, 18, 37.5 per cent.; recoveries, 30, 62.5 per cent.

Time.—Total cases, 48. Total deaths, 18, 37.5 per cent. Within 5 days, 11, 61.1 per cent.; within 10 days, 1, 5.5 per cent.; within 1 month, 3, 16.7 per cent.; after 1 month, 3, 16.7 per cent.

Results.—Total cases, 48. Total recoveries, 30, 62.5 per cent. Useful, 23, 76.6 per cent.; useless, 7, 33.4 per cent.

SUMMARY OF THREE SERIES.—TOTAL CASES, 244.

Frequency of Symptoms.—Crepitus, 93, 37.8 per cent.; deformity, 159, 68.1 per cent.; unconsciousness, 41, 17.6 per cent.; paralysis, complete, 185, 71.7 per cent.; paralysis, partial, 27, 11.3 per cent.; paralysis, none, 32, 13.1 per cent.; pain, 171, 74.8 per cent.; priapism, 66; delirium, 43, 14.7 per cent.; cystitis, 66, 28.0 per cent.; bed-sores, 63, 26.6 per cent.

Regions.—Cervical, 86, 33.9 per cent. Deaths, 77, 85.7 per cent.; recoveries, 9, 14.3 per cent. Upper dorsal, 43, 16.7 per cent. Deaths, 37, 76.7 per cent.; recoveries, 10, 23.3 per cent. Lower dorsal, 75, 32.9 per cent. Deaths, 41, 56.1 per cent.; recoveries, 34, 43.9 per cent. Lumbar, 40, 16.3 per cent. Deaths, 20, 50.0 per cent.; recoveries, 20, 50.0 per cent.

Mortality.—Deaths, 171, 64.5 per cent.; recoveries, 73, 35.5 per cent.

Time.—Total deaths, 171, 64.5 per cent. Within 5 days, 117, 65.7 per cent.; within 10 days, 16, 8.6 per cent.; within 1 month, 18, 12.1 per cent.; after 1 month, 20, 13.3 per cent.

Results.—Total recoveries, 73, 35.5 per cent. Useful, 47, 62.2 per cent.; useless, 26, 37.8 per cent.

The writer recognizes that statistics may be very deceptive, and that they may be made to prove almost anything; yet certain generalizations may be drawn from them. The figures speak for themselves; but it should be remembered that the observations and the records were made by a constantly changing staff of surgeons.

I have purposely refrained from drawing deductions from these figures, for I find that Dr. Crandon, who has carefully gone over the records, arrives at one conclusion and I arrive at another. If two individuals can reach different conclusions from an analysis of the same cases, it shows clearly the fallacy of attempting to generalize from cases that have been observed and recorded by many different surgeons. For this reason the reader must critically analyze these figures and draw his own conclusions.

The most striking statistics are those of the mortality in the first series when compared with the mortality in the third series. In the first series there was 78 per cent. of deaths; in the third series there was 37.5 per cent. of deaths. This extraordinary difference in mortality is due to the inclusion of fractures of the spine which did not have paralysis, in the statistics of the third series. In the first series of cases, if paralysis was not present in some degree, the case was not considered to be a fracture of the spine. For this reason the mortality tables of the summary of the three series cannot be accepted at their face value. Injuries of the spinal column that were formerly considered to be wrenches of the spine are to-day known, in some instances, to be fractures of the spine without cord symptoms. These cases are brought to the hospital with what is thought to be a minor injury, and are sooner or later recognized as fractures of the spine. The nursing care of patients has greatly improved, and this has doubtless diminished the mortality.

The three types of cases that I recognize are the following: 1. Cases in which the cord is crushed. 2. Cases in which doubt exists as to whether the cord is irremediably damaged. 3. Cases in which it is fair to assume that the cord is not irremediably damaged.

1. Cases in which the cord is crushed. This forms by far the largest class of spinal injuries. I append autopsy reports (for which I am indebted to the Pathological Department of the Boston City Hospital) of several of the cases to show the mechanics of absolute cord destruction.

(1) Anterior portion of twelfth dorsal vertebra broken into fragments. Largest wedge-shaped 3 centimetres long, entire body pressed backward. Compressed so that intervertebral disks above and below have largely disappeared. Posterior portion of body forms a knuckle-like mass projecting towards cord, elevated over 1 centimetre above level of the other vertebrae; on the cord, corresponding to the projection of the posterior surface of the body of the twelfth vertebra, is an area of softening 1 centimetre in length. At the lower

border is a marked constriction, the anteroposterior diameter of the cord being reduced one-half. This occurs at a point 3.5 centimetres above the tip of the conus medullaris. The softened portion is grayish white and translucent on section.

(2) Arches of spinous processes of first and second dorsal vertebræ absent (operation). Cord at this point appears normal. No blood in spinal canal. On anterior aspect of spinal column, fifth cervical projects anteriorly 5 centimetres in front of cord, which is dislocated backward. Fourth is freely movable on fifth, and also fifth somewhat less degree on sixth. Body of sixth anteriorly is movable with crepitus, and spinous processes with a portion of arch of this same vertebra can also be moved freely from side to side. There is apparently fracture of transverse processes of fifth cervical vertebra.

(3) Examination of spinal column from anterior surface showed transverse fracture of body of seventh cervical vertebra. Small bony fragments projected into adjacent tissue. Arches of sixth and seventh cervical were comminuted. On posterior surface of dura, beneath arch of seventh cervical and to less extent beneath that of sixth, was a small amount of dark, red coagulated blood. No hæmorrhage within dura. Vessels on surface of cord were injected. Distinct softening of cord opposite point where sixth nerve is given off.

(4) Spines of seventh and eighth dorsal vertebræ not present. Opposite bodies of seventh and eighth cord is sharply compressed by knuckle from posterior portion of bodies. On opening dura the cord was found completely divided, the upper portion being separated from lower by space 4 centimetres. The torn ends of cord end blindly in mass of fibrous tissue. Body of eighth dorsal was seen to have been forcibly driven backward and crushed between seventh and ninth dorsal. Lower portion of ninth exhibited old line of fracture with new formation of bone at about middle of body. No evidence of articular cartilage between eighth and ninth dorsal. Ninth projected into spinal canal at a sharp angle, about 45 degrees. Above angle made by displaced ninth there was a new growth of bone along front of spinal canal, making angle less prominent.

(5) A sharp knuckle of bone is found pushing into spinal canal anteriorly and corresponding to upper portion of body of first dorsal vertebra. This knuckle represents body of first dorsal. The articular cartilage between first dorsal and seventh cervical having been crushed and ligaments torn, the body of vertebra was forced back, producing angle in canal. Cord over knuckle was found softened and discolored by hæmorrhage into it. Microscopically for about 2 centimetres above and below there was blood in posterior horn.

(6) Roughened area in region of first lumbar. Body of twelfth dorsal much narrower on left than on right, bone having been apparently crushed on left side. Irregular fracture body of first lumbar with a fragment projecting posteriorly into spinal canal. Cord degenerated from upper dorsal to cauda equina.

(7) Eighth dorsal vertebra divided by oblique fracture beginning about middle of body and extending on each side upward and backward through body, pedicles, and laminae. Cord for about 2 centimetres opposite site of fracture is narrowed and completely softened. Cord for about 1 centimetre above and below this shows central cavity partially filled with thick red fluid. This cavity corresponds in form and size with portion of cord usually occupied by gray matter. Fluid contains compound granular cells,—irregular nerve fibres.

(8) Upper lumbar displaced to left, dislocation forming marked angle with adjacent dorsal vertebra. Unnatural mobility here. Spines of twelfth dorsal and first lumbar were separated one inch, ligaments torn. Fracture of body of first lumbar. Portion of cord two inches long over displaced ridge of first lumbar distinctly softened. Over projection the cord was brown and diffuent, completely disorganized.

(9) There was a displacement between second and third dorsal vertebræ, body of the second being forced backward and to the right about one-fourth of an inch. This displacement was more apparent upon examination of spine posteriorly, spines and cord having been removed. Second and third spines were broken at their tips. Cord in this region was

overlaid by thin, soft clot, and there was a region of softness one-half inch long, which upon section displayed a considerable effusion of blood into cord. Whole cord at this level was disorganized.

(10) Spinous process of sixth cervical vertebra was broken, and there was a separation between the fifth and sixth, admitting tip of finger. There was also a separation between bodies of fifth and sixth through intervertebral disks, with rupture of ligament to such a degree as to permit displacement of fifth forward nearly one-fourth of an inch. No free blood in meninges. In immediate relation with vertebral injury, spinal cord shows a mass of softening through one-half of its length extending through entire thickness. The consistency and color of cord at this point are that of thick cream.

(11) Examination of spinal column anteriorly reveals nothing abnormal. Spinous processes of the fourth and fifth cervical were widely parted, and fourth was displaced slightly forward. Fracture through body of fourth and through cartilage below it. Cord at this point was compressed, soft, and red. No blood within dura, compression being wholly due to displacement of fragments.

(12) Abnormal mobility between fifth and sixth cervical with anterior displacement of fifth to extent of one-fourth of an inch. Fifth and sixth spines separated, following rupture of their ligaments. Fracture of intervertebral disks below fifth, with separation of articular surfaces of transverse processes. Little blood outside dura; within dura, around cord, very little. At point of fracture the cord was shrunken, soft, and red. The extent of the lesion was about three-fourths of an inch.

(13) Anteriorly, second lumbar presents fracture through its body. Considerable amount of effusion of blood in spinal canal outside dura. Section of dura shows cauda equina without lesion or surrounding hæmorrhage.

(14) Complete crushing of third, fourth, fifth, and sixth cervical vertebræ. Cord not removed, owing to complete destruction and crushing.

2. Cases in which doubt exists as to whether the cord is irremediably damaged. These cases should probably always have an open operation, but will be considered later.

3. Cases in which it is fair to assume that the cord is not irremediably damaged. This class is of great interest and importance.

Dr. L. R. G. Crandon, of Boston, has collected a series of seventeen cases of fracture of the spine without marked cord symptoms which have come under his personal observation. He has pointed out to me that if they are unrecognized they may end most disastrously.

FRACTURE OF THE SPINE WITHOUT MARKED CORD-SYMPTOMS.

1. Male, aged ten years. Buried by a cave-in of sand and gravel; brought immediately to hospital. Marked tenderness over lower dorsal and first lumbar spines, with swelling and kyphos. Reflexes normal and no evidence of paralysis. Patient put on Bradford frame and fastened to it by swathe. Twenty-two days later plaster-of-Paris jacket applied. One month after injury patient up with jacket, and two days later discharged, with marked knuckle in lower dorsal region and definite limitation of intervertebral flexibility, but no evidence of injury to the cord.

2. Male, aged six and one-half years. So far as can be learned, an iron pipe fell on patient's side or back. Patient semi-conscious; color good; pulse 130; slight bleeding from both nostrils; reflexes of eyes, trunk, and extremities normal. Crepitus and abnormal mobility of ninth and tenth dorsal spinous processes of second and third left ribs. Discharged in one month with no evidence of cord-injury, but with slight scoliosis.

3. Male, aged thirty-nine years. Fell into hold of steamer. Pale, conscious, apparently in pain. Sternum fractured. Back shows continuous curve from base of neck to first lumbar with marked kyphos at sixth dorsal. At this point is abnormal separation of spines and great tenderness. No crepitus made out. Abdomen, marked spasm of both upper quadrants. No paralyses, and reflexes all normal. Bradford frame. Retention of urine made catheterization necessary for three days. In eight days the kyphos still persisted, but sensation and motion of lower ex-

tremities were normal. In six weeks sat up with back carefully supported. Plaster jacket applied with spine hyperextended. In eight weeks sat up in chair and was without symptoms.

4. Female, aged twenty-six years. Fell one story, striking on back across an iron fence. Unconscious for an hour. Marked knuckle at twelfth dorsal vertebra. Knee-jerk present on left, absent on right. No paralysis or lack of sensation made out. Bradford frame. Two and one-half weeks, plaster jacket. Radiograph negative. In six weeks was up and about with jacket; no symptoms. Discharged at her own request.

5. Male, aged twenty-two years. "Jack-knifed" while driving through a low doorway. Unable to walk; legs paretic, but sensation normal. Severe pain across back and marked abdominal spasm. Distinct kyphos at twelfth dorsal, but this seems to consist of hematoma and of a loose spinous process, giving crepitus. Retention of urine called for catheterization for seventeen days. At end of two months was discharged with "stiffness of back," but no other abnormality.

6. Male, aged twenty-four years. Fell from a tree about fifteen feet. Conscious. Cyanotic. Pulse, 80; reflexes absent; Babinski on both sides. Both lower extremities delayed in sensation and paretic in motion for twelve hours. After that normal. Eighth dorsal spine unduly prominent; just below it a distinct gap; ninth process not felt. Patient got out of bed several times the first night without new symptoms. Bladder and rectum normal from the first. At the end of one month was discharged at his own request, with plaster jacket; no symptoms.

7. Male, aged twenty-three years. Fell three stories. Conscious; tender prominence over eleventh and twelfth dorsal vertebræ. No crepitus or disturbance of motion or sensation. Reflexes normal. Slight priapism. Bradford frame. In four weeks: priapism continues, but no other cord-symptom has been noted. In one month: patient up (on his own insistence) and walks about, without back support, somewhat stiffly. Discharged.

8. Female, aged twenty-six years. On the tenth day of typhoid developed delusions, and jumped from a second story window to the ground, about thirty-five feet. The patient was unconscious, respirations were rapid and shallow, slight cyanosis. There was marked prominence of the ninth, tenth, eleventh, and twelfth dorsal, and first lumbar vertebræ, with evident separation

of spines of twelfth dorsal and first lumbar. No paralysis or anæsthesia. Abdomen distended. Kyphosis persists. Death at end of three days.

9. Male, aged thirty years. "Jack-knifed" under a bale of cotton. Conscious. Crepitation and abnormal mobility of eleventh dorsal spine. No paralysis or anæsthesia. Discharged well.

10. Male, aged forty-seven years. Fell one story down elevator well. Slight kyphos at second lumbar vertebra. Reflexes, sensation, and motion normal. Sat up in twelve days, with no sign of injury except the persistent knuckle.

11. Male, aged thirty-two years. A mass of twenty-eight bricks fell on patient's bent back. Conscious. Marked separation of fourth and fifth dorsal spines, enough to admit tip of finger. Just above this, fourth spine is unduly prominent. No paralysis or other sign of cord injury. Up and about in fourteen days without symptoms.

12. Male, aged thirty-eight years. Fell down stairs. Conscious. Soft swelling in dorsolumbar region. Twelfth dorsal spine unduly prominent. Sensation, reflexes, sphincters, and other muscles not affected in any other way. Discharged in seventeen days against advice.

13. Male, aged sixty years. Was thrown down a flight of stairs. Conscious. Dyspnoea. Abnormal mobility, crepitus, and pain over third and fourth dorsal spines. Discharged without symptoms in four days.

14. Male, aged sixty years. Fell off a bridge. Conscious. Reflexes normal. No loss of motion or sensation made out, but a marked kyphos over eleventh and twelfth dorsal spines. Much abdominal spasm. No symptoms of cord injury developed during two months. At the end of that time, although the deformity persisted, patient was up and about in plaster jacket.

15. Male, aged thirty-two years. Fell thirty-five feet from an electric-light pole. Conscious. Reflexes normal. General abdominal spasm. No loss of motion or sensation, but a definite kyphos over first lumbar spine. Retention of urine first twenty-four hours. Discharged in two months with persistent kyphos and wearing plaster jacket.

16. Male, aged twenty-six years. Intoxicated and in a fight fell from a second story window to the ground. Conscious. Color good; breath alcoholic; pupils equal and react; tongue

protrudes straight; pulse 100, regular, good quality; fine tremor of both hands. General abdominal tenderness and spasm; no motor paralysis. Slight prominence of spine of first lumbar vertebra. Considerable tenderness over this region; some pain on motion; no crepitus or abnormal mobility of spinous processes; able to move legs without difficulty; sensation normal. Plaster jacket applied with lordosis. Discharged after seven weeks. Able to walk slowly, with great sensation of weakness in lumbar region and dependent upon plaster jacket.

17. Male, aged forty-one years. Tried to jump from one roof to another and fell four stories. Semiconscious. Apparently in great pain. Marked pallor. Pupils equal and react. Tongue not protruded on request. Pulse 120, regular, but of poor quality. Marked kyphosis, with apex of the knuckle at the junction of the tenth and eleventh dorsal vertebræ, where there is considerable separation of the spines. Marked abdominal tenderness and spasm. Knee-jerks absent. Cremasteric present. Patient grew worse through the day, and in five hours was in a state of collapse. A pint of adrenalin solution, 1 to 50,000, was introduced into the vein of the arm, and this was repeated twice at intervals of six hours. Pulse immediately responded and general condition improved. There was no motor paralysis at any time. The patient was kept on a Bradford frame, and was discharged at the end of four months with a plaster jacket. This man was brought into the hospital by the police in a chair, his head and the upper half of the trunk collapsed forward. A knuckle in his back presented, the whole picture being that of Pott's disease. Immediate rectification was done to the extent only of placing the man on his back, and there he remained until complete union had taken place. At no time were there any cord symptoms.

This series of cases is, I think, worthy of careful consideration. Presumably in the past these cases have not gone to a hospital. The injury to the vertebræ in some of these cases is assumed from the symptom-complex, not from the existence of crepitus and abnormal mobility. It must be remembered that in certain adult spines there is present a kyphos that is not dependent upon an obvious pathological lesion.

There can be but little doubt that cord symptoms may

develop from the displacement of a fracture of the spine where the cord has not been permanently injured. Dr. Crandon has seen one such case that deeply impressed him. It is as follows:

Male, aged fifty-five years. Fell down an elevator well and was brought immediately to hospital. There was marked tenderness over the seventh cervical and the three upper dorsal vertebræ, together with slight spasm of the neck. No crepitus made out. Pulse, 74; temperature, normal; respirations, 17. No paralysis or anæsthesia. Reflexes present and normal. Full control of sphincters.

Patient was put to bed, and cautioned not to sit up or to roll in bed, because there was injury to his back which might be more than was then apparent. Four days after injury, however, when unattended, *he sat up in bed and immediately complained of numbness of the limbs and body.* Examination then showed a paresis of all the skeletal muscles from the neck down and diminished cutaneous sensation from the clavicle downward. Reflexes increased. Abdomen somewhat distended. Bladder parietic and sphincter ani relaxed.

Two days later the plantar reflexes and the knee-jerks were absent; absolute paralysis of lower extremities. Right arm: very slight power of flexion and slight power of supination; extension of elbow lost; pronation of wrist lost; very slight power of deltoid; pectorals and latissimus dorsi lost. Sensation blunted to pin-prick over ulna half; sharp over ball of thumb; blunted over both sides of forefinger; lost over middle finger; sharp over deltoid; sharp over radial aspect of forearm. Left arm: flexion good; extension of forearm lost; deltoid, pectorals, and latissimus fair; pin-prick of limb diminished; radial aspect diminished; over deltoid normal; ulnar side diminished. Sensation absent from toes to level of fourth rib, and blunted from fourth to second rib. Pupils equal and not dilated. Diagnosis: Complete injury at seventh segment; sixth segment blunted.

Operation advised at the first onset of these symptoms. Not accepted, and patient died at the end of a month, with the usual picture of fractured spine and complete destruction of the cord. Autopsy showed fracture of the first dorsal and complete degeneration of the cord at that level, but without macroscopic change in the envelopes of the cord.

In the care of this class of bony injury of the spine, surgery can protectively be of great value. To the police, to hospital attendants, to house officers, and to medical students, the instruction for the care of injuries to the back should be "*hands off.*" Let the patient be transported to the surgeon, so far as is possible held fixed in the position in which he is found.

Can we tell whether a spinal cord is irremediably damaged or not? In some cases it is obvious from the character of the injury that the cord is severed or crushed. A total transverse destruction of the cord may be deduced from the *persistence* of the following symptoms: the total loss of all reflexes, complete insensibility to touch and pain, and motor paralysis below the level of the lesion.

Thomas,⁶ whose work on the changes in the spinal cord following fracture of the spine is of great value, stated that the "factors in drawing the conclusion that there is a complete transverse lesion of the cord are:

- "1. Complete paralysis, usually of a flaccid type.
- "2. A complete loss of sensation in all its forms.
- "3. Absent reflexes, especially the knee-jerk, while the plantar reflex, on the contrary, is often retained.
- "4. Complete paralysis of the bladder and rectum, with priapism.
- "5. Vasomotor paralysis, with severe sweating in the paralyzed parts.
- "6. And, most important, absence of variations in the symptoms.
- "7. Absence of irritative phenomena, such as pain."

Walton,⁷ who has studied fractures of the spine, states, "There are no symptoms which establish (otherwise than through their persistence) irremediable crush of the cord." "While total relaxed paralysis, anæsthesia of abrupt demarcation, total loss of reflexes, retention, priapism and tympanites, if persistent, point to complete and incurable transverse lesion, the onset of such symptoms does not preclude a certain degree at least of restoration of function." He also states that we have no infallible guide to the extent of the lesion.

Treatment.—The treatment of fractures of the spine comes under the following headings: (1) Expectant; (2) reduction and fixation; (3) operation (laminectomy) which may be (a) primary; (b) secondary. The selection of the kind of treatment should depend on what injury to the cord exists or what injury to the cord is likely to occur.

(1) Expectant treatment. This mode of treatment is applicable to fractures of the spinous processes or even of other bony structures where there are no cord symptoms. The expectant treatment consists in having the patient fixed in bed, preferably on a Bradford frame, to facilitate his care. The nursing care is most important. The expectant method is one which manifestly holds out little hope of complete recovery in cases of definite cord injury.

(2) Reduction and fixation. The immediate, bloodless, rectification of a fracture of the spine, and its fixation by a plaster-of-Paris jacket, was the mode of treatment which I advised in selected cases in my first series. If a detailed local examination is to be made, the patient should be turned only as a whole. Rectification should be attempted very slowly, so far as is possible, in the axis of the spinal column. During every step of this operation it is desirable that the condition of the cord, as shown by sensation, motion, and reflexes, should be known. Should the slightest sign or symptom of cord injury or pressure develop, the rectification should stop and an immediate open operation be done. If the kyphos is very marked, or if upon extension it does not readily reduce, an immediate operation, unless there is some contraindication, such as shock, should be done, that the reduction may take place while the cord is under the surgeon's eye. The deformity may be corrected and the jacket applied, with the body suspended, or by the horizontal hammock suspension position. In short, the jacket should be applied *after* reduction has been attempted by firm even pressure at the site of the deformity, with enough hyperextension to open the narrowed canal to its normal limits.

In 1887 I collected sixteen cases of immediate rectifica-

tion of the spine and fixation with a plaster-of-Paris jacket. Of these, three died, three derived no benefit, and ten were greatly improved. The conclusions reached by the writer in 1887 were as follows:

"First: That, in the *immediate* correction of the deformity and fixation with plaster-of-Paris jacket or other means, we have a rational method of treating a large number of cases of fracture of the spine. Second: That, considering the hopelessness of results in fracture of the spine when treated expectantly, almost any risk is justifiable. Third: That the *immediate* correction of the deformity is imperative, *if* softening of the cord can and does occur from pressure at the end of forty-eight hours. Fourth: That the suspension of the patient is only a means of rectifying the deformity; that certain fractures could be simply pressed into position while the patient lies prone or supine.

"The objections to the treatment are,

"1st. That the expectant plan of treatment gives a small percentage of recoveries. 2d. That there are serious risks, especially in the cervical region, attending the suspension of a patient and the rectification of the deformity with a fractured spine, in the way of shock, collapse, and death. 3d. That in attempting to relieve pressure on the cord, by rectifying the deformity, we might either sever the spinal cord or make pressure upon it. This is a matter of chance.

"My own belief regarding the status which the procedure should occupy in surgery is, that it will occasionally be a life-saving measure; that it should be applied under anæsthesia in all cases of fracture of the spine which are not conclusively known to be irremediable; and that, apart from the chance of recovery offered to the patient by this means, it will almost invariably make the patient more comfortable, in that he can be handled more easily."

In 1894, in the second series (86) cases, the percentage of recovery was 33. The treatment had been influenced by the first paper in 1887. In the first series of cases, 18 patients recovered; 9 recovered "useful," that is, could walk; and 9 recovered "useless," that is, were bedridden. In the second series of cases (86), 28 recovered; 19 were "useful," and 9

were "useless." Not all of the cases were treated by the immediate rectification of the deformity; in fact, it was applied during the year 1887 four times; during the year 1888 twice; during the year 1889 three times; during the years 1890 and 1891 twice; and only once in 1893.

More experience, as is usually the case, has brought more light; and I now believe that the indication for immediate reduction and fixation is for cases of fracture with no cord symptoms, and for cases not hopeless which refuse an open operation.

(3) Laminectomy. The technique of the operation that I use is practically described by Munro.⁸ A single incision is made in the median line and is carried down to the lamina on either side close to the spinous process. The wound is packed and the lamina on the other side is exposed in like manner. The interspinous ligaments above and below the selected spine are cut with blunt scissors curved on the flat. The spinous process itself is bitten off with a rongeur, the laminae are next cut near the middle line with small bone forceps, and the intervening piece removed, thus exposing the cord without even putting it in danger of injury. Successive laminae should be removed until it is positive, without any chance of error, that all compression of the cord, above and below, or of spinal nerves still in the canal, is removed. The dura should be opened freely; spicules of bone should be removed; the dura should not be sutured, and drainage by a bit of rubber tissue may or may not be necessary.

In the open operation lies our hope,—a hope, unfortunately, and nothing more. The advocates of operative surgery of spinal cord injury are divided into those who favor immediate operation and those who advise a delayed operation. Relatively few surgeons are in favor of an operation within a few hours. The arguments against immediate operation are that an injury which has involved destruction of the cord is already done, and will get no worse in a few hours. The patient is still suffering from spinal and general shock.

I believe in immediate operation unless it is distinctly

contraindicated by shock. The reason I believe in immediate operation is that no one can positively state in what condition the spinal cord is until he looks and sees, and if pressure exists on the spinal cord, and it is allowed to persist for many hours, irreparable damage to the cord may result. I recognize that it would be advisable to exclude spinal concussion, which at times might simulate pressure on the cord, but while waiting for the spinal concussion to clear up, if pressure on the cord exists, irreparable damage may result. I agree largely with Walton and Lloyd in fearing delayed operation in cases which have recovered from their first shock and have in them anything objectively hopeful.

OLIVER⁹ states that "a point which has been regarded as very important in these cases is the length of time that elapses between the receipt of the injury and the performance of the operation. The usual advice has been to operate as soon after the infliction of the injury as is possible, because of the fear that prolonged pressure may of itself produce degenerative changes in the cord from which the patient never recovers." Dr. Oliver states that "analysis of the statistics seems to throw some doubt upon the correctness of this dictum." He instances cases by Lauenstein, McCosh, Huss, Starr, Wyeth, and one of his own cases, where recovery had occurred from late operation on a fracture of the spine. Dr. Oliver says, "If the injury is not irreparable at the time of accident, it is unusual for bony or other pressure to cause a permanent abolition of function."

I recognize that the successful laminectomies for fracture of the spine have almost invariably been late operations. Notably this is the fact in Horsley's cases. If, however, the late operations are successful at times, it perhaps may be assumed that these same cases would have been successful if an operation had been done early; at least, they would not have been subjected to the risk of uncertainty as to whether pressure on the cord was producing irremediable damage. I cannot believe that pressure on the cord should be allowed to persist any longer than is imperative from the general condition of the patient.

THORBURN¹⁰ is pessimistic. Speaking of seven cases of operation, he says, "In none of the cases did any real benefit result; all those in which the injury was in the cervical region died; all those in which it was below the cervical lived, but did not recover from paralysis." "The published cases, of which there are about 200, show to my mind no better results, if we exclude injuries of the laminae, hæmorrhage, and operations upon the cauda equina. I have, indeed, not satisfied myself that there have been any successes, as regards recovery of function, save such as may be attributed to the regeneration of nerve roots only, or to the natural recovery of a cord which was but very slightly injured." "And, further, if it were shown that in one or two instances among the 200 published cases there had been a definite improvement or recovery, I should be inclined to regard such as the sequel of some error in the original diagnosis, rather than to allow a single instance to invalidate a rule based upon such extensive premises."

LLOYD¹¹ is more hopeful and, it seems to me, just in his estimate of the surgical results in these cases. He says, "It is, therefore, evident that if we operate immediately after the injury we will have failures that should not be charged against the operation itself, and, if possible, we should wait before operating until the question can be settled whether the patient will overcome the shock or succumb directly to the effects of the injury."

"There is another objection to immediate operation. In so-called concussion of the spine, there may be a certain amount of anæsthesia and paralysis. The recovery, however, will be complete, or at least so nearly so that no appreciable lesion can be made out. Immediate operations in these cases would be unnecessary, as they would have recovered spontaneously had they been left alone for a sufficient length of time. It is impossible, too, in the first few hours, to determine with any degree of certainty how severe the injury really is, nor can we absolutely localize the injury to the cord. In my opinion, therefore, we should wait until this period of shock has passed and until it is evident that there will be no spon-

taneous recovery complete enough to render life bearable. If, after this period has passed, the patient still continues to improve, no operative interference should be considered, but as soon as the symptoms begin to show retrograde phenomena or seem to have reached the end of the improvement operation should be undertaken."

LLOYD¹² published the following table of laminectomies in 1902:

Cervical Region.	Immediate Operation.	Later Operation.
Deaths	21	2
Recovery	0	2
Improved	2	1
Not improved	0	4
Subsequent death	4	3
	—	—
	27	12
Dorsal Region.	Immediate Operation.	Later Operation.
Deaths	23	5
Recovery	4	10
Improved	9	18
Not improved	6	16
Subsequent death	7	16
	—	—
	49	65
Lumbar Region.	Immediate Operation.	Later Operation.
Deaths	4	4
Recovery	1	6
Improvement	1	6
No improvement	0	4
Subsequent death	0	2
	—	—
	6	22
Sacral Region.	Immediate Operation.	Later Operation.
Deaths	0	0
Recovery	0	1
Improved	0	3
Not improved	0	0
Subsequent death	0	0
	—	—
	0	4

He states that "these statistics are decidedly against immediate operation, and we must urgently advise never operat-

ing until it is evident that the patient will not succumb to the direct effects of the injury. As soon, however, as he has recovered from the shock and his exact physical condition is known the operation should be performed."

VICTOR HORSLEY's cases, reported to the British Medical Association in 1895,¹³ are the most brilliant. Of the seven cases reported, three were fractures of the spine. They are as follows:

1. "There was a fracture of the cervical spine, with paralysis of all four limbs, which had lasted eight months. The paralysis began to extend. Analgesia was present, and this always points to an affection of the central gray matter of the cord. The laminae of the fifth and sixth cervical vertebrae were removed, and the thick fibrous tissue was dissected off the dura mater. The patient steadily improved, and only wasting of the interossei remained."

2. "The patient had fallen from a cart, striking his head and right shoulder. He walked about for a week, but gradually lost power in all his limbs. When admitted to Queen's Square Hospital, fracture of the sixth cervical vertebra was diagnosed. The left optic disk was swollen. Laminectomy of the fourth, fifth, and sixth cervical vertebrae removed a ridge which had been pressing on the spinal cord. Power began to appear on the twelfth day. He has since recovered completely."

3. "The patient sustained a fracture of the sixth cervical vertebra; the onset of paralysis was gradual. There was marked contracture and well-marked anaesthesia of the postaxial border of the upper limbs. The arches of the sixth and seventh cervical vertebrae were removed when a projecting ridge was felt, but on extension this disappeared. He is recovering slowly."

The last case may have been a fracture of the spine, and is reported as follows: "The patient had struck the fore part of his head, and after walking 200 yards rapidly became completely paralyzed. After partial recovery spastic paraplegia appeared, with postaxial anaesthesia of the upper limbs. The laminae of the sixth and seventh cervical vertebrae were removed. Permanent recovery commenced three weeks after the operation. He can now walk a mile."

The following is a list of some of the laminectomies that have been collected from the literature of the subject since Lloyd published his table. It must be recognized that it is not common for surgeons to publish their unsuccessful cases:

VAN ENGELEN¹⁴ reports three operative cases.

1. Paraplegia as the result of a fresh fracture. The cord was found crushed to a pulp; death in fourteen days.

2. Fracture of skull and spine, apparently dying. After trephining both skull and spine consciousness returned, motor and sensory power in the lower extremities reappeared, but patient died three weeks later from tetanus.

3. A young woman after fracture of the spine suffered paraplegia and pains of the legs. Since sensation was retained, operation was done. Paraplegia was not relieved.

HAHN, E.,¹⁵ reports four cases.

1. Man, aged fifty-one years. Fell three stories; much shock, paralysis of both legs. Sensation doubtful because drunk. Next day pulse better, paralysis persisted, reflexes gone, incontinence, complete loss of sensation from Poupart's down. Operation three weeks later. Fracture third lumbar up to twelfth dorsal. A fragment of twelfth dorsal narrowed the canal, pressing along 1 centimetre of the cord. The dura was opened and the wound drained. Pain was relieved and sensibility improved for a time.

2. Man, aged thirty-eight years. Fell twenty-five feet; conscious, with pain, paralysis of right leg and bladder; some power in left leg, which disappeared in twenty-four hours. Reflexes lost, sensibility of legs much diminished. Retention of urine, incontinence of faeces. Operation in six days. Fracture of the first lumbar, change in canal noted anteriorly. The cord compressed slightly but not torn; wound drained. Some sensation returned, but patient died in one week.

3. Man, aged forty years. Fell three stories; paralysis of both legs; sensation lost from pubis down. Operation nine weeks later. First and second laminae removed. A bit of bone was driven under the cord and compressed it from behind, forward. Fragments were removed. In one week bladder and rectum improved. The wound healed. Four months later the patient was discharged, with mobility and sensation not improved.

4. Man, aged twenty-two years. Fell twenty feet into water, and his horse fell after him; swam ashore with arms only; had pain in the back and was numb in the legs. Sensation of legs gone, mobility from hips down lost. Operation three days later. Fracture of last dorsal and first lumbar, compression of cord by fragments, dura not open, the cord seemed normal. Died without improvement.

WINNETT¹⁶ collected six cases which may be called successful, and to these added one of his own on which Peters operated. The cases are as follows:

1. Surgeon, McCOSH. Man, aged thirty-three years. Eighteen months previously sustained a fracture or dislocation of the fourth, fifth, or sixth cervical. For nine months bedridden. Caused by shackle falling on his head and doubling him up. Completely paralyzed below the clavicles. At time of operation, atrophy of muscles, but stands with

assistance. Spastic paralysis of left arm. Some use of right arm, but not of hand. Constant pain in upper limbs. Operation. Fourth displaced one and a quarter inches to left. Removed arch of fifth; dura very vascular and attached to arch. Not opened. Result: Gets about, uses arms, walks four miles, and writes with left hand.

2. Surgeon, JOHN A. WYETH. H. A., aged twenty-one years. September 1, 1889, thrown from a cow-catcher to track. Loss of motion from pelvis down; bladder and rectum paralyzed. Operation, April 30, 1890. Removed laminae, last two dorsal, and upper two lumbar. Bodies found crushed, and cord partly divided. Undivided part compressed by laminae of vertebra above and body below. Compressing bone was removed and dura closed. Result: Immediate slight improvement in motion, especially in feet. In 1894, good use of legs and feet, but uses cane.

3. Surgeon, RIDENAUER. M. N., aged twenty-eight years. December 11, crushed by an overhead beam in such a manner as to crush centre of his back forward at an acute angle, frightfully lacerating and crushing parts. Seventh dorsal depressed one inch, and eighth absent. Lamina of seventh dorsal broken and separated. Transverse processes of seventh torn off. Intervertebral disks of seventh forward one inch. Spinous process of eighth penetrating cord. Body of eighth fractured. Membranes punctured and lacerated, and hæmorrhage into arachnoid space. Operation: Removed roof from sixth and ninth dorsal. Sensation returned at once. Motion in recti at end of fourth day. Catheter required till seventh day. Sphincter ani restored at end of first week. Knee-jerk restored at end of second week. Lift limb from bed at end of fifth week. Walk with crutches at end of three months.

4. Reported in *American Journal of the Medical Sciences*, April, 1892. Fracture dislocation between tenth and eleventh dorsal. Opened five hours after, and large extra-theclal clot washed away; vertebræ reduced, and spines held together by silk. Paralysis and hyperæsthesia passed away.

5. Surgeon, BOYLE. S. M., aged twenty years. Struck in back by train May 8. Loss of motion and sensation below hips. Reduction failed. For first week catheterization. Pain and hyperæsthesia in both legs. Operation: July 12. Dislocation backward between ninth and tenth, above and forward of last dorsal, and first lumbar below. All arches removed and bodies grooved. Second day after operation slight movement in toes, also sensation. At present has good sensation and motion.

6. Surgeons, CHURCH and EISENDRATH. Fracture dislocation of tenth dorsal, with complete paraplegia. Extra-dural hæmorrhage found, clot removed, and vertebræ reduced. Result: Cured.

7. Surgeons, PETERS and WINNETT. Male, aged twenty-nine years. Dived into four feet of water, his head doubling under him. Physical examination: Mind clear, sensations normal down to nipples. Tactile sensation present, but indistinct over the remainder of the surface, with

the exception of the forearms and hands. Contact of clothes was hot and painful. No other pain since. Retention of urine. Paralysis of rectum. Contraction of pupils. Irregularity of fourth and fifth cervical spines. All muscles below the neck, except the diaphragm, paralyzed. A small spicule of bone was found in the membranes over the fourth left lamina. The spine of the fourth was bent to the left. The membranes were opened, blood and spinal fluid escaped, and pulsation returned. The case was discharged the nineteenth week, with bladder normal, and patient able to move left hand.

The writer presents the following conclusions:

First. That fractures of the spine may well be divided into two classes: first, fractures of the spine with injury to the cord; and, second, fractures of the spine without injury to the cord.

Second. That it is not best to decide what the treatment of an individual case of fracture of the spine should be from the statistics, because the lesion varies so widely.

Third. That in many cases of fracture of the spine it is impossible to primarily state whether the cord is crushed or pressed upon by bone, blood, or exudate, except by an open operation.

Fourth. That only by the *persistence* of total loss of reflexes, complete insensibility to touch and pain, and motor paralysis below the level of the lesion, can total transverse destruction of the cord be diagnosticated.

Fifth. That if pressure on the cord is allowed to remain for many hours, irreparable damage to the cord may take place.

Sixth. That unless it is perfectly clear that the cord is irremediably damaged, an open operation to establish the condition of the cord and to relieve pressure is imperative as soon as surgical shock has been recovered from.

Seventh. That in certain cases of fracture of the spine, when the cord is not injured but is liable to injury from displacement of the fragments of a vertebra, rectification of the deformity and fixation of the spine may be used.

Eighth. That if the cord is crushed, no matter what treatment is adopted, there will, of necessity, be a high rate of mortality.

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A CASE OF SUTURE OF THE SPINAL CORD FOLLOWING A GUNSHOT INJURY INVOLVING COMPLETE SEVERANCE OF THE STRUCTURE.¹

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A. E., aged eighteen years; clerk; born in the United States; single; was admitted to the Brooklyn Hospital on April 28, 1903, with the following history:

Shortly before admission he had been shot in the back, his assailant using a .38-caliber revolver at a distance of about thirty feet; the shooting took place somewhat from the right side. He suffered severely from shock, and paralysis of the lower extremities occurred at once.

Examination on admission. The bullet wound was located one and one-fourth inches to the right of the median line and on a level between the tenth and eleventh dorsal spines. He is found to be paralyzed below the waist, sensation is absent over all of both lower extremities and over the abdomen as high as one inch above the crest of the ilia on the sides, and about half-way between the symphysis and the umbilicus in front. The bladder and rectum are also paralyzed. The bowels move involuntarily and irregularly and without the volition or cognizance of the patient; there is considerable twitching of the muscles of both legs, especially the toes.

Operation May 9, 1903. Ether anæsthesia. An incision was made six inches long over the spines of the vertebræ, the middle of the incision resting upon the eleventh dorsal spine. The laminæ of the tenth, eleventh, and twelfth vertebræ were removed by the chisel. The bullet was found lying transversely between the severed ends of the cord, concealed from view by a large blood-clot. A very narrow, ragged, and contused strip of dura,

¹ Read before the American Surgical Association, July 6, 1905.

scarcely more than one-eighth of an inch in width, remained intact. The blood-clot was carefully sponged away and the bullet removed. The ends of the cord were then sutured with three fine chromicized catgut sutures, the dura being included in the sutures. No special difficulty was experienced in drawing together the ends of the cord and closing the defect, the latter representing in width the diameter of the .38-caliber bullet. The dura was further secured with a number of sutures of fine catgut, and a drain consisting of a half-dozen narrow strips of oiled silk protective introduced. The skin incision was sutured with silk-worm gut.

On May 30 the following note appears on the hospital record: "Wound healed, upper line of anæsthetic area from one and one-half to three inches lower than before operation. Twitching of toes of both feet and occasional clonic muscular spasms of the flexors and extensors of the thighs; the patient says his 'feet jump up on him.' Can feel when the bowels move, but is without control of the rectum. Can feel distention of the bladder with urine, but is without control." „

Examination by Dr. William Browning on June 7.—It is found that no sensation can be definitely determined in the lower extremities which responds to any test, except where some muscular contraction occurs following motions producing pain, as spasm by jarring. There are frequent slight movements in the toes, these being noticeably present in the big toes. There is no cremaster jerk; the knee-jerk cannot be developed even by pulling down the patella. Ankle clonus is absent; Achilles jerk present on both sides. It is not certain that he can move either toe at will; occasionally he would appear to do so, but more often the motion would be in the other foot; in fact, there is so much spontaneous motion as to make what otherwise might appear to be a movement in response to the will purely accidental. Babinski's reflex in extension symptom (the upward jerk of the toes) is present on each side; there is also some upward motion of the toes on plucking out hairs on the front of each leg.

During July bed-sores developed on the buttocks and heels. These became quite deep, the sacral sore extending to the muscles. During November a cystitis developed, and irrigation of the bladder was done daily for about eight weeks, and urotropine, four grains every four hours, administered. Under this treatment the

cystitis improved. Patient was encouraged to sit up and go about in a wheel-chair, when the bed-sores healed rapidly. In January, 1904, a lobar pneumonia developed, from which the patient recovered without any untoward event. During the spring and summer of 1904 the sensation of the presence of the contents of the bladder and rectum was greatly improved. Occasional recurrences of cystitis were kept under control by irrigation and urotropin. Following the healing of his bed-sores he was treated by massage and electricity, and has taken daily walking exercises, assisted by an attendant, in a cage-like support resting on wheels, arranged somewhat like the "baby-tender" of the nursery. With the aid afforded by this support and braces to stiffen the knees, he manages to move about from place to place in the hospital.

During the winter of 1904 and 1905 his bladder and rectal sensations improved. He is now able to tell when a movement of the bowels is imminent, and at times is able to retain it for awhile. The same is true of the bladder. Erections are easily excited and persistent, but not painful. Both legs are spastic and quite useless for locomotion, except with the help of the apparatus above mentioned.

The following is a report of his condition in January, 1904, by Dr. F. C. Eastman, assistant in neurology at the Brooklyn Hospital:

Sensation.—This is abolished in the legs and trunk as high as a line extending across the front of the body at a point one and one-half inches above the pubes, and in the back represented by a curved line about half an inch below the level of the iliac crests. Above this there is a zone of marked hyperæsthesia about two inches in width, though there is some irritability of the whole cord above the level of anæsthesia. There is an area about five inches in length extending down the outer side of the right thigh where there seems to be some sensation, but the patient is not able to correctly distinguish between heat and cold, nor is he able to correctly localize tactile sensations, which are usually referred to a point two or three inches distant.

Voluntary motion is completely lost in the affected area. There is loss of bladder and rectal control, the former at least acting automatically; the patient is able to tell just before the act that he is about to urinate.

The abdominal and cremasteric reflexes are lost. Virile and

epigastric reflexes present. The knee-jerks are exaggerated, particularly the left. The Achilles reflex marked, particularly on the right side. Right Babinski reflex more marked than left. Permanent right ankle clonus is absent on the left side. Marked rigidity and spasticity of both legs. Tendency to priapism. Left leg one-quarter of an inch larger than the right. Left thigh one-quarter of an inch larger than the right.

Trophic Changes.—Slight atrophy of both legs, probably from disuse. Marked atrophy of glutei muscles on both sides. The muscles involved are apparently situated too far down for this atrophy to be the result of destruction of the cells of the anterior horn at the point of lesion, so that it may be simply from disuse, as these muscles atrophy more readily than any others in the body.

The skin is somewhat dry and scaly, but there is very little trophic disturbance at the present time.

Examination made by Dr. Eastman on the 12th of June, 1905, shows the data to be practically identical upon comparison with the former report, with the following exceptions: In the former examination it was stated that the anæsthesia extended upward in front to a point one and one-half inches above the pubes. It is now found that the anæsthesia extends to the pubes and no further; the area of anæsthesia on the right leg and on the back, however, corresponds perfectly with the former findings. There is no reaction of degeneration of any of the leg, thigh, or gluteal muscles.

Remarks.—The main points of interest in this case relate to the possibility of regeneration of the spinal cord following a destructive lesion. Prior to the case reported by Dr. F. F. Stewart and Dr. R. H. Harte, in which the cord was sutured after it had been severed by a bullet, it was the opinion of the majority of investigators that such regeneration in man did not take place. Mikulicz, of Breslau, endeavored to demonstrate the possibility of a successful regenerative process in the lower animals following section of the cord, but without result. Spiller and Frazier found that after division of a posterior root in the dog, followed by immediate suture, regeneration occurs, and that regeneration into the cord does not occur.

In comparing the result in the case reported by Dr. Stewart with the conditions present in the case herewith reported, the following points are worthy of note: Sixteen months after the injury, in Dr. Stewart's case, the patient was able to flex the toes, flex and extend the legs and thighs, and rotate the lower extremities. While in the sitting position she could raise the extended leg from the floor, and she was able to stand by supporting herself with her hands on the back of a chair. The bowels were under control except when diarrhoea was present, and moved every second day. The urine passed voluntarily amounted to about sixteen ounces in twenty-four hours; incontinence occurred during sleep. She had the sensations of touch, temperature, pain, and locality; the difference between heat and cold, however, was not always distinguished. Rigidity of the muscles was present in a moderate degree; both ankle clonus and patellar clonus were present on each side. Reaction of degeneration absent. No bed-sores had ever developed, and the skin and nails showed no trophic changes.

In the case herewith reported, the following is to be noted in comparison: Twenty-six months after the injury voluntary motion is practically lost in the affected area. He is able to stand when supporting himself by the hands resting upon an apparatus, and to make some locomotion by swinging movements in a special frame on wheels. The bladder and rectal control is doubtful, to say the least, the former acting automatically. He has the sensation that the bladder and rectum are about to empty themselves, and if the urinal or bedpan is brought to him promptly soiling is prevented. The amount of urine passed in this manner would probably average more than a pint in the twenty-four hours. Urine is sometimes voided during sleep. Sensation is practically abolished in the entire affected region, with the exception of an area about five inches in length extending down the outer side of the right thigh, where some sensation is present. He is not able to correctly distinguish between heat and cold. Tactile sensations are recognized, but are usually referred to a point two or three inches distant from the point touched. Marked rigidity and

spasticity of both legs are present. Patellar reflex exaggerated; Achilles reflex marked. Ankle clonus present on one side and absent on the other. The reaction of degeneration is absent. Upon this point, Dr. Eastman reports as follows:

"I examined E.'s muscles as you desired, and can report that there is no reaction of degeneration of any of the leg, thigh, or gluteal muscles; further than that I cannot say positively. I could not get the reaction in any of the muscles that I tried. The trouble is that the back and abdominal muscles, which are supplied with nerves from the point of the lesion, are innervated from so many segments that lesion of any one segment does not destroy their activity, and then I could not react at all some of the muscles in the deeper layers of the back." Bed-sores developed in the third month; these extended to the muscles and were six months in healing. The skin shows but slight, if any, evidences of trophic disturbance.

An important comment is suggested in comparing these cases, namely, the Stewart-Harte case was operated on three hours after the injury, while in the present case upward of ten days had elapsed before consent to interfere operatively was obtained. The prolonged separation of the divided ends of the cord and the presence of the foreign body had, in all probability, an influence in preventing a complete regeneration of the cord, as occurred in the first case, provided, of course, that regeneration does actually occur. While the case in hand is therefore not as striking in many of its features as the Stewart-Harte case, it presents some points of interest, and for this reason is offered as a contribution to the literature of the subject.

Finally, the influence exercised by the possible presence of undiscovered portions of the cord, or of nervous structure in portions of the dura remaining intact in these and similar cases, may be taken into account. It may be that this takes place also in connection with injury of the cord occurring as the result of fracture of the vertebrae, and the varying end result of operative interference in different cases may be accounted for in a

measure by the varying extent to which a final nerve anastomosis may take place through the medium of uninjured portions of the dura. This suggests likewise the occurrence of a relatively efficient nerve anastomosis through the medium of branches of adjacent nerve-trunks having their origin respectively above and below the lesion, and this in turn to the possibility of still further enhancing this effect by operative anastomosis of the nerve-trunks themselves. This, of course, assumes a relative limitation of the ascending degenerative process with elements of the cord as well as of the axis-cylinders of the divided and sutured nerve-trunks, and resulting innervation of the parts below the lesion and of those supplied by the injured segment of the cord, conditions not incompatible with those that may have been obtained in the Stewart-Harte case, and to a lesser extent in my own case.

TUBERCULAR CONDITIONS OF THE SPINE RE-QUIRING SURGICAL AND MECHANICAL RELIEF.¹

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OF the tubercular and inflammatory conditions which affect the spine, the most common pathological process encountered is that mixed infection, tubercular and inflammatory, which is the result of spinal caries.

The most prominent surgical measures employed for the relief of this condition are: 1. Laminectomy for Paraplegia; 2. Forcible Immediate Straightening of the Kyphosis; 3. Forcible Gradual Straightening of the Kyphosis; 4. Erasion of Carious Bone; 5. Wiring of the Spinous Processes; 6. Evacuation of Pus Accumulations.

1. *Laminectomy*.—In the majority of cases, especially in children, the carious process may be arrested and a cure effected by rest, hyperextension, and fixation of the diseased area for a long period of time; yet in a certain number of instances a deposit of tubercular material within the spinal canal, enveloping and pressing upon the spinal cord, produces partial or complete paralysis of motion and sensation. Following this tubercular deposit an ascending or descending pachymeningitis may result, with permanent thickening of the membranes sufficient to interfere permanently with nerve transmission. Pus formation may still further interfere with function. Added to the pressure already alluded to may be bony pressure from caries of the vertebral bodies, thus angulating the canal, and in some instances narrowing the caliber by actual bony encroachment. In 98 per cent. of the cases, however, the

¹ Read before the American Surgical Association, July, 1905.

diminution of caliber and the interference with nerve transmission are due to the first-named causes, while in only 2 per cent. is compression due to bony pressure. This fact is readily appreciated when it is noted that some of the worst cases of spinal caries paraplegia are those in which the kyphosis is moderate or even small, and again that paralysis is absent in cases of most marked posterior angularity. The region of the spine most prone to yield the paraplegic complication of spinal caries is the upper dorsal, where the bony canal is limited in size, and where even a small amount of intraspinal deposit yields most serious consequences. The clinical experience of every surgeon, however, has taught him that even a severe grade of paraplegia may recover, although great angularity still exists, provided the tubercular and inflammatory deposits are absorbed. The amount of paralysis and the consequent symptoms will depend upon the position, extent, and character of the tubercular deposit. A child affected with spinal caries begins suddenly or slowly to show evidences of feeble locomotion; loss of sensation; increased knee-jerks and ankle clonus; rigidity of limbs; gradual contraction of some group of muscles; frequently, loss of control of sphincters of bladder and rectum; sometimes priapism, persistent and painful. Fifteen or twenty years ago the exceptionally good results secured in a few cases by Macewen, Horsley, Lauenstein, and others, encouraged us to hope that in laminectomy we had found a speedy method of relief. Unfortunately, larger and fuller personal experience has demonstrated that while a few cases are permanently benefited by operation, yet that the mortality is high, and, even when temporary improvement takes place, relapses were common and permanent benefit uncertain.

The operation, therefore, while it has not been abandoned, has, like trephining of the cranium for epilepsy, been limited in its application and made secondary to other measures. Those measures have for their object the arrest and lessening and limitation of the bony destructive process and the permanent bridging and repair of the destroyed vertebral bodies. Added to these should be the employment of all the hygienic

measures available. Among the latter it is unnecessary to say that sunlight and fresh air hold the first places. In my experience, the prognosis in spinal caries paraplegia under so-called conservative methods has been so successful that I hesitate, save in very exceptional cases, to recommend operative procedures until other measures have failed. Thorough and complete rest, fixation of the diseased area, and progressive forcible straightening have yielded such good results that I have now many cases walking the streets which for a period of more than a year seemed incurable. I am inclined to prolong the treatment even to two years, when signs of improvement are evidenced. Of course, to be effectual, the rest should be absolute, the diseased vertebræ being so fixed that motion of the diseased bones is reduced to a minimum. This can be accomplished by head extension in bed, by hyperextension upon a Bradford or Goldthwaite frame, by plaster of Paris, or other fixed dressing to the spine. Internally, the iodide of potassium and iodide of iron are helpful, but rest and fixation are the prime elements in the cure. Should the paralysis continue beyond eighteen months or two years, the removal of the laminæ may, however, assist in the relief of the paraplegia, especially when the cord can be cleared from tubercular deposits. The mortality is unfortunately so high that after many years of test I find myself resorting less frequently than formerly to laminectomy for caries paraplegia, while in traumatism of the spine I am more and more convinced of the benefit of early interference. When the vertebral bodies are carious, a laminectomy removes the only remaining healthy portion of the vertebræ, and to a considerable extent weakens the column. The advantage of laminectomy is that it removes pressure from structures each fibre of which is necessary for vital function, while in the brain, individual cells are not so essential. Although asepsis has greatly diminished the dangers of the operation, yet in a certain number of cases laminectomy opens the way for spinal infection, and the results of the pachymeningitis remain or are increased. Fortunately, the pachymeningitic deposit in some cases will be found localized and can be removed.

If the bony angulation with pressure in front of the cord were the chief cause of the loss of motion and sensation in the lower extremities, it would certainly be wiser to push our operative results to a greater degree, even to the extent of severing the spinal nerves in order to reach the source of trouble in front of the cord and then to reunite these nerves. An immediate mortality of 25 per cent. is very high, especially in a disease which is not in itself necessarily fatal, particularly as this rate is augmented during the first month by other deaths reaching more than one-third. If to this mortality be added those late deaths that are not directly the result of the operation, yet follow within a year, we find that at least in one-half of the cases life has been shortened. Final results following laminectomy are exceedingly difficult to obtain, since caries is a disease in itself, one that has to be judged by years not months, and an early report is valueless. The published reports would indicate that 65 per cent. may reasonably be placed to the credit either of deaths or of not having been materially or permanently improved. Naturally, however, these patients were all serious cases at the time of the operation.

A few words in regard to technique. Incision to one side of the dorsal median line, the cutting off of spinous processes and pushing them to one side, lessens hæmorrhage. Hæmorrhage and the removal of the first laminal arch constitute the delays in the operation. Many hæmostats and very hot packing should be at hand. Many surgeons prefer cutting bone forceps for taking away the first arch; I use either gnawing forceps or a Hey's saw. The fatty tissue and the ligament subflava are at first confusing, but as soon as the cord is exposed all hesitancy disappears. If the dura is yellow, there is probably pus within the membrane. A surgeon who has performed the operation only once or twice upon the upper portion of the spinal column realizes but little the difficulties and dangers of the procedure in the lower column. One danger of the operation is that blood leaking into the canal may cause additional compression and paralysis by travelling down the subdural space. Postmortems show that similar extravasations of blood

may take place on the cornua or on the columns, producing further paralysis. After secondary degenerations have taken place, improvement in the paralysis is not to be expected. One of the great dangers of laminectomy, especially low down, is the risk of later infection from bed-sores or from pus sinuses. The neuropathic bed-sores are especially dangerous from the extent of the trophic changes, while leakage of infected and decomposing urine is also most serious. Laminectomy is much less hopeful in spinal caries than in fractures and other traumas, since pachymeningitis, compression myelitis, or meningomyelitis may all be present in the former. All undue handling, even sponging of the cord, adds to the shock. The cord may be rolled to one side, but any extensive bone erosion is to be accomplished from the side, not across the cord space. If nerve-roots are injured, they should be sutured. When the extradural deposit is considerable and its removal possible, the dura should not be opened, as any fissure in this membrane is liable to permit tubercular infection within the membrane. To sum up, then, the dangers of laminectomy are its high mortality from shock and hæmorrhage, infection, suppuration, extension of myelitis or pachymeningitis, failure to permanently relieve, and weakening of the column. The advantages are the removal of tubercular masses in the canal, the removal of pachymeningitic deposits and of pus, the relief occasionally of anterior bony pressure, and, lastly, allowance for posterior expansion. In some instances marked benefit results both as regards motion and sensation. Relief of vesical symptoms alone well repays.

2. *Forcible Immediate Straightening of the Kyphosis.*—

The method of immediate forcible straightening of the spine by hand pressure, as revived by Calot, the patient lying prone with pelvis and shoulders elevated upon blocks, is simply a new form of the barbaric methods practised before the time of Hippocrates. In those days a man's feet were bound to a ladder, and he was then dropped head downward from the top of a building. In other cases a long beam was used as a lever, with the kyphotic spine as the fulcrum, by which method,

of course, it was easy to crush any amount of deformity into the straight line. Hippocrates states that this method was employed "by those physicians who seek to astonish the mob and never give themselves any concern as to the result of the procedure, whether good or bad."

Looking at the operation both pathologically and clinically, it is unsurgical and unscientific. Upon its revival, I preferred that other surgeons should try it rather than myself, and I have never had occasion to change this opinion. I have resorted to the procedure a few times in old hopeless cases, but the operation has died the death to which it was entitled. To break up an already ossified bridge and leave a carious gap certainly is not conducive to the strength of a column; if pus is present, infection is probable. It has been shown pathologically that the material thrown out in the process of repair does not contain sufficient calcium salts or bone-producing material to give proper strength to the new bone. Since a cure can only be expected by an ossifying osteitis and a fixation of the spinal column capable of sustaining the superincumbent weight of the shoulders and head, the effort aimed at should not be, as in the immediate forcible operation, to produce a gap in the front of the spine which experience has shown can never be fully filled, but to secure as large an amount of ossifying material as possible and a bridge of most secure pattern. While the muscles may for a time hold the spine in position, they must ultimately give way, and relapses commence after the removal of the support.

Cases in which advantage has been secured in the relief of paraplegia are undoubtedly where the cord pressure has been relieved by the altered straightening of the column: the disadvantages are insufficient support causing weakness of the spine; subsequent recurrence; dissemination of tubercular material; increase of disease by local injury; production of general tuberculosis; injury to the cord; fresh suppuration. In some cases the paraplegia has been rendered worse, and in one instance the wall of the abscess was ruptured sufficiently to admit tubercle bacilli into the mediastinum.

3. *Gradual Correction of the Deformity.*—Forcible hand pressure upon the kyphosis at varying periods or by using the hump as a fulcrum and bringing to bear upon it the weight of the body above and below the disease, is a much safer process than immediate fracture. The advantages gained by such straightening must be immediately fixed by the application of a plaster-of-Paris cast. By this method a small amount of gain is secured, but all that is justifiable or to be expected safely. It is undoubtedly true that a large proportion of so-called straightening of the spine is due not to actual improvement of the kyphosis, but to the alteration of the curves in other portions of the column. In forced lordosis, bringing the weight of the body upon the posterior region rather than upon the vertebral bodies, is probably a large element in the benefit secured. This is true whether suspension is used or whether the dorsal fulcrum is applied directly to the kyphosis. The recumbent position upon a curved frame and extension in bed with a pad under the kyphosis during the acute stage is the best method of preventing deformity; then fixation for a long period of time by some form of splint adapted to each particular region of the spine, that is, in the cervical region the head should be thoroughly splinted, not by suspension or by a jury-mast, but by prolongation of the steel uprights so as to hold the head firmly in position with rigid splints. In the upper dorsal the same method is necessary; in the lower dorsal or lumbar either a steel or leather or similar jacket may be employed. Success depends upon the careful and long continuance of retention appliance for a sufficient length of time to produce a strong bony bridge. With the screw elevation shown in Fig. 1, the kyphosis and the spinal column are forced into hyperextension while the gypsum is applied. The plate over the hump is protected by a large, loose, felt cloth pad, which remains. Before the plaster fully hardens, a slit is made over the plate, which latter is so hinged that it can be withdrawn through a small opening. This opening can be closed at once by patching with plaster. A muslin suspension sling answers a similar purpose (Fig. 2).

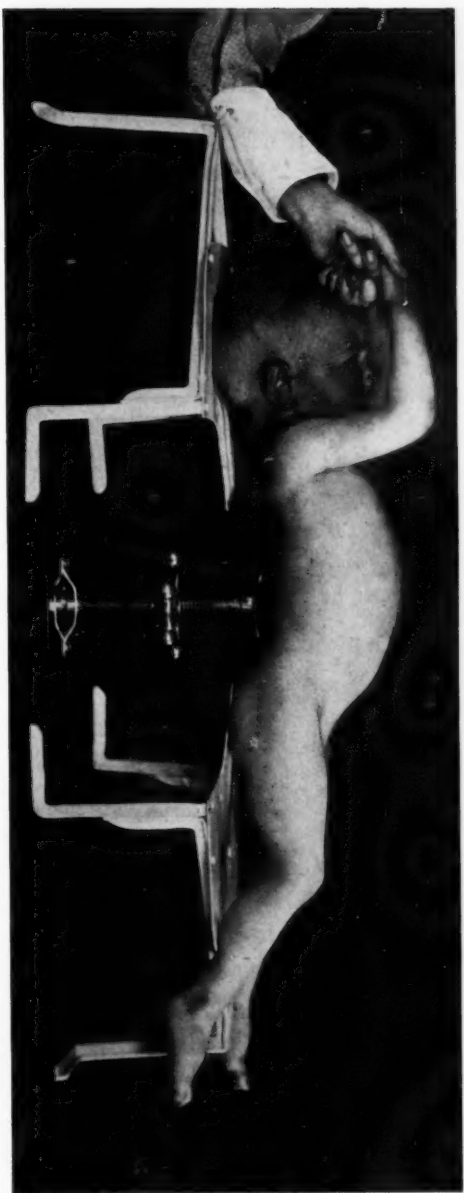
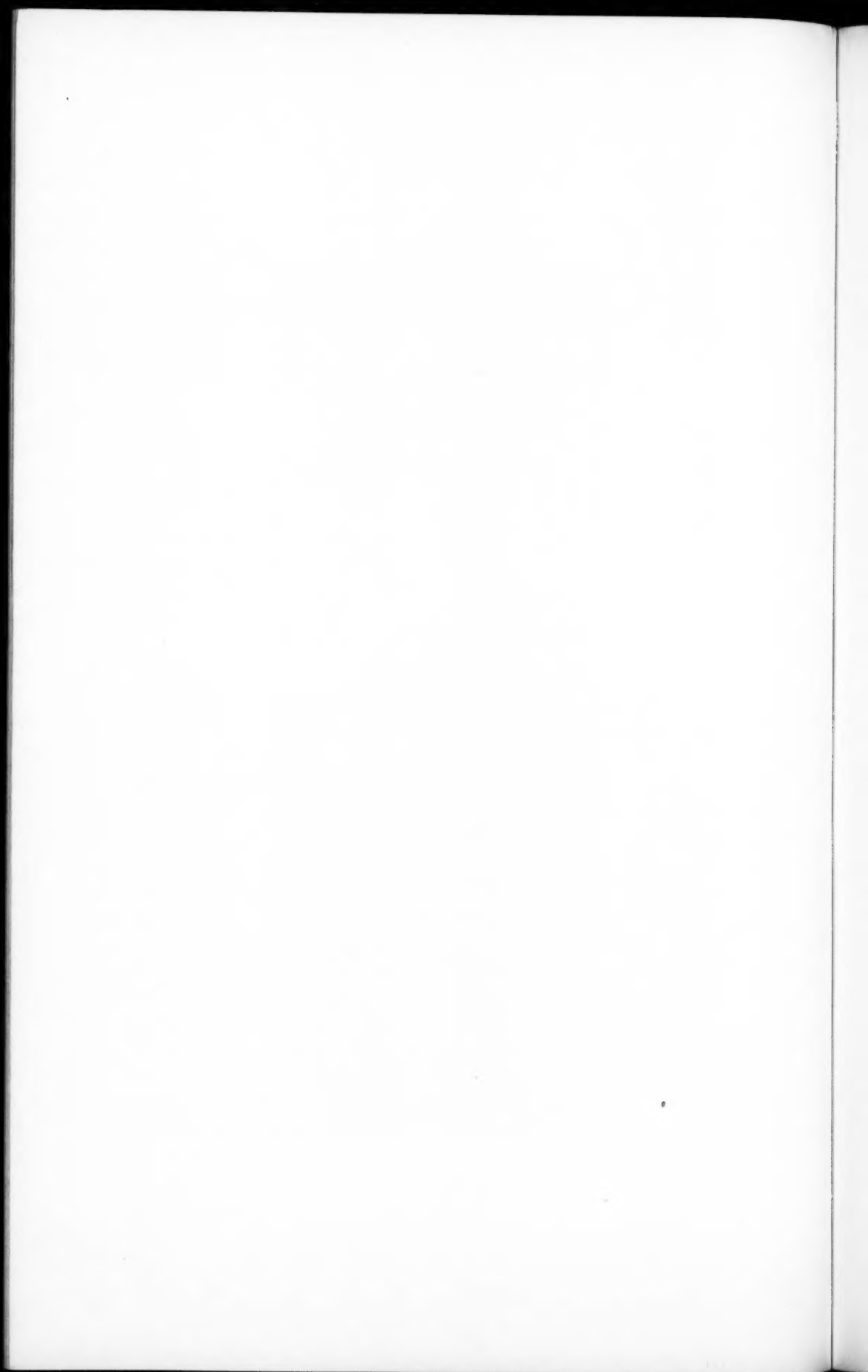


FIG. 1.—Screw upright for straightening kyphosis while plaster-of-Paris bandage is being applied for permanent fixation in hyperextended position. Plate is hinged, so as to be withdrawn flat through slit.



4. *Erasion of Carious Bone.*—Theoretically, the operation of erasion is a good one; practically, the anatomical difficulties encountered are well-nigh prohibitive to that absolute removal of all carious tissue which is so essential to a complete and rapid diminution of pus formation. Of course, as long as we have any dead bone remaining, the discharge will continue. If the disease were situated principally or simply in the posterior regions, of course removal would be easily accomplished; but since it is the bodies of the vertebræ that are chiefly diseased, the absolute removal of all diseased tissue is problematical. The bodies of the lumbar vertebræ are large

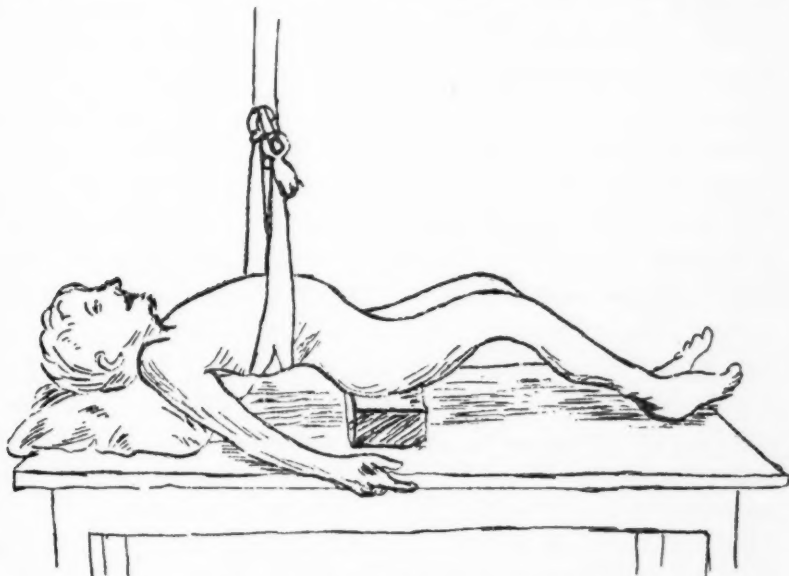


FIG. 2.—Muslin bandage for temporary suspension during application of gypsum. (Bradford.)

and lie far from the surface of the body; a careful inspection is impossible, and manual palpation fails to discern diseased bone from the roughened surfaces left by a gouge in cancellous tissue. One has but to examine a cross-section of a body as seen in formalin or frozen sections to note the difficulties of completely reaching and removing the entire body of the vertebræ even in a cadaver. In the dorsal region still greater difficulties are encountered. To reach the bodies, portions of

ribs must be excised, a costotransversectomy; the pleura lies in close proximity, and the wounding of this membrane opens new avenues for infection. The operation of erasion in this region is only applicable in cases where a large intrathoracic abscess has pushed the pleura forward and where manipulations can be conducted from inside the sac, a condition difficult to diagnose in advance. The twelfth dorsal can be reached from below through the psoas; but it should be remembered that the pleura is close at hand, sometimes extending as low as the liver and the transverse processes of the first lumbar. In the cervical region, a certain amount of diseased bone may be removed, but seldom all. In all these regions, therefore, the results are uncertain. The X-ray may assist in locating the disease, but even taken in connection with clinical symptoms is not positive. In the lumbar region too long an operation is not advisable, as the multitude of muscles, tendons, and strong fascia render the operation difficult, bloody, and uncertain. The immediate risks of the operation are considerable. To a certain extent, however, the suppurative process may be shortened by the amount of dead bone removed; the chief advantage gained is drainage.

5. *Wiring of the Spinous Processes.*—Wiring of the spinous processes as a means of inducing fixation of the column has been occasionally used, but not with sufficient frequency to determine its usefulness. Theoretically and mechanically the method seems only fairly helpful.

6. *Evacuation of Pus Accumulations.*—Surgeons vary in their methods of dealing with pus accumulations from spinal caries. Some still insist that cases progress more rapidly if the abscess is permitted to remain quiescent and to be absorbed or encapsulated. In some instances such a result is undoubtedly possible, but it is risky and usually unsuccessful. My own practice is to aspirate such accumulations so long as the liquefaction of caseation is drawn, but when the suppurative process is added to the tubercular, asepsis through drainage from spine to groin is best, provided subsequent cleanliness can be secured, a result which is undoubtedly possible with the exercise of constant vigilance.

CONCLUSIONS.

1. Complete methodical and long-continued fixation of the spine in the position of hyperextension, with healthy surroundings in the sunlight, are the prime factors in securing new ossific deposit necessary to replace the carious bone.

2. Laminectomy for paraplegia is advisable only after long-continued and patient treatment along the above-named lines from one to two years, since the prognosis, especially in children, under these conditions is favorable, and good powers of locomotion may be confidently expected. The operation is justifiable in selected cases where loss of motion and sensation are progressively worse and the symptoms threaten life. If the tubercular masses within the spine can be removed, and if extradural pachymeningitic deposits or pus can be taken away, improvement may be expected, and in many cases relief occurs. The operation has a mortality of about 25 per cent. from immediate shock, 36 per cent. within a month; while one-half the cases die within the year, their lives being probably shortened by the operative procedure. Cases of non-improvement and death equal nearly 65 per cent.

3. Forcible immediate straightening of the kyphosis is an unsurgical and dangerous proceeding; it is liable to reawaken the tubercular disease and to weaken the column.

4. Forcible gradual straightening by supporting the kyphotic area upon a pedestal is a valuable agent in relieving deformity. The weight of the shoulders and pelvis can thus be utilized as straightening forces and the weight of the column thrown upon the posterior arches. In this position it is permanently fixed by plaster of Paris.

5. Complete erasion of the carious bodies of the vertebrae is an uncertain operation; in the dorsal region requiring section of ribs, with danger of wounding the pleura.

6. Wiring of the spinous processes has never been sufficiently tried to demonstrate its helpfulness.

7. Spinal abscesses which contain only liquefaction of caseation should be aspirated. When true pus has formed, aseptic through drainage is advisable.

THE SURGICAL TREATMENT OF INTRASPINAL TUMORS.¹

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AMONG the many fields of surgical activity which owe their present advanced state largely to the labors of physicians, few have owed so much in the past or still owe so much to them as that of spinal tumors, although to a surgeon—von Leyden (1874)—is due the first suggestion of an operation for the amelioration of the symptoms produced by this disease. Nor, I think, would any surgeon presume at the present day to perform laminectomy for a suspected intraspinal growth without consulting a neurological colleague, even were the surgeon himself capable of diagnosing and of accurately localizing the tumor. It is therefore not the purpose of the present paper to treat at length of the symptoms and diagnosis of these affections; it is quite sufficient to recall briefly the salient features which would in the case of any patient suggest to the surgeon a neurological consultation.

Pain is usually the symptom first complained of, and is generally of a rheumatic or neuralgic character, localized to one limb, or to certain of the intercostal nerves. It is frequently more or less completely relieved temporarily, but persistently returns, and constantly grows more severe. To the pain is next added—often, however, not for some years—a numbness and heaviness in one or more of the limbs. The symptoms are almost invariably unilateral at first, but with equal constancy become bilateral before paresis has fully developed. Girdle sensation, with a zone of hyperæsthesia immediately above the limit of the anæsthetic area, is also usually

¹ Read before the American Surgical Association, July, 1905.

observed. Early in the course of the disease the affected limbs are spastic, but later the reflexes are lost, and in time the muscles lose their reaction to the Faradic and to the galvanic current as well. The loss of certain of the sensations, as those of heat and cold, while others are retained, considered characteristic of syringomyelia, is also sometimes observed in tumors pressing on the spinal cord; and several instances are known where operations, undertaken for the removal of supposed spinal tumors, have relieved, at least temporarily, the syringomyelic symptoms by the evacuation of the cystic collections found in this disease. Local physical symptoms of a tumor are usually absent, such symptoms, for example, as deformity and rigidity of the spinal column, or tenderness on pressure over the site of the tumor; but when such symptoms are present, they are of course a considerable aid in diagnosis, when tuberculous caries of the spine can be excluded.

The science of spinal localization is now so well developed that it usually is not difficult to determine with accuracy the location of an intraspinal growth; and since multiple growths are exceedingly rare, the chances for successful removal of a spinal tumor would be overwhelmingly favorable did success depend upon localization alone. But besides this factor we must also consider the inherent difficulties of the operation, the nature of the tumor, and its relation to the membranes of the cord.

In searching the literature for reports of operations for tumors of the spinal cord, a number of cases have been found which do not strictly come under this classification. What is usually understood by the term tumor of the spinal cord is an extramedullary but intraspinal growth like a sarcoma, a fibroma, or a myxoma, giving no evidence of its existence except by the symptoms of medullary pressure which it produces. Thus, tumors of the spinal column—osteomata, enchondromata, or sarcomata, which are palpable externally, and are readily diagnosed by an ordinary physical examination—should not be included unless by extension into the vertebral canal they produce medullary symptoms. Cases of pressure

on the cord due to traumatism or to tuberculous caries of the spine are also of course excluded. But I have included in my tables certain cases in which, although there were present external symptoms of the growth, there was nevertheless no direct connection between the two. For instance, a case reported by Curtis, in which laminectomy was done for spinal involvement secondary to carcinoma of the breast, has been included, although such extension of malignant growths is not very unusual,* and such cases do not strictly belong to the class of intraspinal tumors. No cases have been included, however, in which laminectomy was a mere incident in the removal of a growth extending into the spinal canal, but in which it was an operation not intentionally undertaken to relieve the symptoms of spinal irritation.

There have been found records of 92 operations for spinal tumors, among which number 43 patients died,—a total mortality of nearly 47 per cent. McCosh has stated (*Journal of the American Medical Association*, 1901, ii, 621) that the mortality of laminectomy *per se* should not be more than 10 per cent.; and if from the percentage above given we omit those cases, 17 in number, ultimately known to be fatal, but in which death ensued some weeks or months after the operation, we can reduce our mortality to 26 cases, or 28 per cent. Even with a mortality of nearly 30 per cent., it does not seem to me that the surgeon should hesitate to operate in these cases, since, even when a cure cannot be obtained, relief from the pain is almost invariably secured, and the patient in most instances lives as long as he would have done if no operation had been performed.

The nature of the tumor is recorded in 88 of the reported cases. It was sarcomatous in two-fifths of the whole number (37 cases); † adhesions, thickenings, etc., hold second place,

* C. N. Dowd (New York Medical Record, 1898, i, 347) collected histories of twenty-nine cases of mammary carcinoma, in five of which there had been distinct symptoms of involvement of the spine.

† Of Schlesinger's 400 cases of spinal tumors, one-quarter was sarcomatous.

with 11 cases; then comes echinococcus, 8 cases; fibroma, 6 cases; syringomyelia, 5 cases; endothelioma, 4; psammoma, 3; cyst, 3; fibromyxoma, 2; osteoma, 2; and one each of myeloma, lipoma, lymphangioma, dermoid cyst, primary and secondary carcinoma, and one tumor of bone whose nature is not stated. In only three instances where the patient recovered from the operation did no improvement follow it. Two of these were cases of inoperable sarcoma, and the third was a case of syringomyelia. The annexed table shows that of those patients, 49 in number, who survived the operation for some weeks or months, no less than 29, or 59 per cent., recovered their functions sufficiently to be classed as cured; that 17, or 34 per cent., could be classed as improved by the operation; while in the condition of only three patients, or 6 per cent., as mentioned above, did the operation effect no change.

Variety of Growth.	Total.	Died.	Cured.	Recovered.	
				Im- proved.	Not Im- proved.
Sarcoma	37	20	8	7	2
Adhesions, etc.	11	5	4	2	0
Echinococcus	8	3	5	0	0
Fibroma	6	2	3	1	0
Syringomyelia	5	2	0	2	1
Endothelioma	4	2	1	1	0
Psammoma	3	1	1	1	0
Cyst	3	0	2	1	0
Fibromyxoma	2	1	1	0	0
Osteoma	2	0	2	0	0
Tumor of vertebra	1	1	0	0	0
Myeloma	1	0	0	1	0
Lipoma	1	1	0	0	0
Lymphangioma	1	0	1	0	0
Primary carcinoma	1	1	0	0	0
Secondary carcinoma ...	1	1	0	0	0
Dermoid cyst	1	1	0	0	0
Not stated	4	2	1	1	0
	92	43	29	17	3
					49 Recovered.

In discussing the sarcomata recorded here, it may seem audacious in the extreme for a surgeon to mention such a thing, but it does not seem impossible to me that in some

instances the microscopical diagnosis may be in error. It certainly appears from this table, where 17 out of 37 sarcomatous patients are reported as having recovered from the operation, that sarcomata of the spinal canal do not possess that extreme malignancy which characterizes them in other parts of the body. When three such patients are reported as in fair health at a period of more than six months after the operation, and five are said to be well at the end of from two and a half to five years after the operation (of which latter cases two patients, surviving more than four and five years respectively, had intradural sarcoma), it makes one very sceptical as to the reliability of histological diagnoses. Some of these cases are reported as having an infiltrating sarcomatosis, practically inoperable; yet, after cautious curettement of the external surface of the diseased dura, no recurrence is noted even when years have elapsed. Cushing's case is reported frankly enough as one in which reasonable doubt existed as to the diagnosis between fibrosarcoma and fibroma; and McCosh likewise states that, in view of the subsequent history of his patient (no recurrence after two and a half years), it is probable that the tissue removed at operation was granulation tissue and not sarcomatous in character. But other observers, especially the German surgeons, do not seem to have been struck by this point. We all know with what melancholy regularity sarcoma recurs in amputated stumps and in extirpated glands; but when it occurs along a man's spinal marrow, it seems that we may expect its removal to insure against recurrence in nearly or quite half of the cases.

I have included in the table twelve operations where symptoms of spinal tumor were produced by meningeal thickenings or adhesions. In at least five of these cases (Macewen's) the patients had suffered from Pott's disease of the spine in previous years, and a kyphosis still remained; but no tuberculous process was found at the operation, and with Starr's tables (*American Journal of the Medical Sciences*, 1895, ciii, 613) of spinal tumors as my authority, I have thought it proper to include them with tumors rather than among cases

of laminectomy for spinal caries. I have myself recently done the operation of laminectomy on a patient with old Pott's disease, in whom no active bone disease was found, but in whom the paralysis appeared to be due to extradural thickening, and not to actual compression from the angulation of the spine.

CASE I.—*Paraplegia from Pott's Disease; Laminectomy; Great Improvement.*—Harry S., aged twenty-six years, was admitted to the Orthopædic Hospital, Philadelphia, September 5, 1904. There was no tuberculous family history obtainable. The patient had had pneumonia at two years, scarlet fever at five years, and diphtheria at seven years of age. In 1896, when nineteen years old, he had typhoid fever, which was complicated by phlebitis in both lower extremities, the right being the first affected. After about three months of convalescence his legs ceased to swell. In 1898 he entered the army, and fell and struck his left knee-cap. The injury was not severe, but there was much swelling and a good deal of pain. For this condition he was admitted to the Pennsylvania Hospital, June 29, 1898, under the care of the late Professor Ashhurst. The diagnosis was tuberculous arthritis of the left knee. In July some iodoform emulsion was injected into the joint. In August an abscess, apparently tuberculous in character, formed on the inner middle aspect of his right arm. This was opened and drained. In September, 1898, the patient was discharged from the Pennsylvania Hospital, walking with crutches. Six months later, in May, 1899, he returned to the Pennsylvania Hospital for examination, and was under my care. His limb was in good condition, and he had a fairly useful knee. He was allowed the use of his leg. After this date he states that the abscess on his arm opened again, and that his shoulder became stiff. In 1901 he was again admitted to the Pennsylvania Hospital, and the knee-joint was found so badly diseased that it was thought impossible to further pursue conservative treatment. Dr. Barton Hopkins accordingly amputated the left thigh in its lower third. The patient made a good recovery from the operation, and returned to his home in Harrisburg. Not long after this date he noticed a hump the size of a hickory-nut in the lower dorsal region of his spine. He complained chiefly of pains in the lumbar region, and was treated for lumbago. He was not seriously incommoded, how-

ever, until June, 1904, when he suffered from what he describes as remittent fever, being confined to bed for two weeks. When he got out of bed, he noticed that a numbness which he had felt for some months around his hips had increased, and also that his foot was numb. He very soon lost the use of his body and limbs below the waist-line.

On admission to the Orthopædic Hospital, in the autumn of 1904, he was paralyzed from the waist down, and sensation was markedly impaired throughout the affected area. He had retention of urine and a severe grade of cystitis. The stump of his amputated left thigh was in good condition. There was very marked kyphosis in the lower dorsal region. Extension was applied to his head and right leg, and measures were adopted to relieve the cystitis. Sensation improved somewhat, the cystitis was finally cured, and the patient regained control of his bowels and bladder. He also became able to flex the great toe occasionally, and by contracting his abdominal and psoas muscles he could barely move both thighs. He remained in this state for many months, and, as no further improvement seemed probable, the question of laminectomy arose. He was examined by one of the neurological staff, who advised against any operation. Nevertheless, on April 27, 1905, nearly eight months after his admission, laminectomy was undertaken, the patient being willing to undergo any operation that offered him even the remotest chance of improvement. A cure was not anticipated. The spines and laminae of the ninth, tenth, and eleventh dorsal vertebrae were removed, and some extradural thickening dissected out. Practically no shock attended the operation, and on recovery from the anæsthetic the patient expressed himself as being able to feel the bed under him in a much more real way than he had done before. He said he no longer felt dead below the waist. Gradually increasing power in the great toe developed, and at the end of four weeks sensation was perfect all over the lower extremities, all the toes could be freely moved, the ankle-joint could be flexed and extended at will, the knee and thigh could be raised from the bed, and the amputated thigh could likewise be moved. Before the operation, when one or two movements of the great toe had been made, all power was exhausted, and no further motions could be made for some hours. Now he can move his muscles at will all day long.

With very few exceptions, it is impossible to determine the nature of the tumor before operation. Gummata may nearly always be excluded; they are very rare in the spinal canal, and it is never worth while to delay operation for the sake of trying antisyphilitic treatment. According to Starr (*Journal of the American Medical Association*, 1901, i, 202), only twenty-six gummata were found in a series of 400 cases of tumor of the spinal cord. Sarcoma can only be diagnosed with certainty when the spinal lesion is clearly secondary to similar disease elsewhere in the body. The only other tumors found which are frequently secondary in origin are hydatid cysts. Among the eight recorded operations for this condition, three were palpable over the spinal column, and one of these (Trendelenburg's) was reoperated after four months for recurrence.

In a case recorded by Hale White (*Transactions of Clinical Society of London*, 1900, xxxiii, 140), Fripp operated twice on a young man with spinal pressure from a dermoid cyst in the upper dorsal region. Although on the first occasion the growth was found to be inoperable, yet so much relief was experienced for a period of two months, that another attempt was made to relieve the patient, but unfortunately without success, as the case terminated fatally in eight and a half hours. This young man had suffered from Hodgkin's disease for a number of years; but it was clear, even before the first operation, that the spinal pressure was unconnected with that condition. In the autumn of 1904 I operated on a case of dermoid cyst of the spine, and, although there were no symptoms of involvement of the spinal cord, I desire to place it on record.

CASE II.—*Dermoid Cyst of the Spinal Canal; Operation; Recovery.*—E. T., a girl, aged seven years, was admitted to the Episcopal Hospital, Philadelphia, August 31, 1904, under the care of Dr. H. C. Deaver. She presented a diffuse swelling over the sacrum, cystic and semifluctuating to the touch, and extending well over to both buttocks. This condition had existed since birth, and had been considered a spina bifida. A few days be-

fore admission she had been struck over the tumor. A small abscess formed, and was opened September 13, 1904, being apparently superficial, and not connected with the spinal tumor. She was discharged from the hospital on September 22; but was readmitted on October 3, coming then under my care, with high fever and evidences of infection of the spinal growth. After appropriate local and general treatment, which caused subsidence of the constitutional symptoms, it was determined to attempt the removal of the spinal tumor, which produced great deformity in the child, as well as interfering with her sitting comfortably on a chair. Accordingly on October 21, 1904, I dissected the cyst out, finding it adherent to the coccyx and the lower sacrum. Part of the coccyx was removed. The wound healed uneventfully though slowly, and the patient was discharged, cured, February 2, 1905. The appearance of the growth at operation was typical of dermoid cyst, and the pathological report confirmed the diagnosis. "The section is undoubtedly tissue from a dermoid tumor in which the connective tissue predominates. There are small areas of epithelial structures, such as serous glandular tissue and extensive areas showing mucosa and submucosa, with solitary follicles and agminated lymph-glands. There are numerous blood-vesels and scattered foci of hæmorrhagic infiltration, considerable fatty tissue, little smooth muscle, but no voluntary muscle." *

It has usually been stated that extradural tumors were much more frequent and much less fatal than intradural growths. I do not find this to be the case, however. There are 87 cases in which the situation of the tumor with regard to the dura is mentioned; in 50 of these it was extradural, and in 36 intradural,—not such a very striking difference. The death-rate, moreover, in the extradural cases was even higher than that of the intradural tumors, being 50 per cent. for the former and only 47.21 per cent. for the latter. This may perhaps be explained by the fact that sarcomata are more frequently extradural than intradural (of 37 sarcomata 16 were intradural and 21 extradural), and that they are also more apt

* In connection with the subject of dermoid cysts of the spine, see an interesting article by Bland Sutton in the *ANNALS OF SURGERY*, 1889, ii, 81.

when intradural to be circumscribed or encapsulated, and thus removable with little damage to the surrounding parts; whereas the extradural sarcomata are frequently infiltrating, and may involve the spinal column and surrounding muscles very extensively. Nevertheless, the danger attendant upon intradural operations must not be ignored, since we find that among these operations, all done with antiseptic or aseptic precautions, no less than six of the intradural terminated fatally from meningial infection, whereas only one of the fatal extradural cases has meningitis recorded as the cause of death.

Malaisé (*Deutsch. Archiv für klin. Med.*, 1904, lxxx, 143) has recently written an elaborate article on the diagnosis between intra- and extramedullary tumors of the spinal cord, but in no case reported to-day was it possible to tell before operation the relation of the growth to the dura, much less the fact whether it was in the substance of the cord or not. In only two of these cases (except, of course, those of syringomyelia) was it found at operation that the medullary substance was involved in the growth. These were Fenger's case of spindle-celled sarcoma and Warren's case of endothelioma. The former terminated fatally on the fourth day from septicæmia, but Dr. Warren's patient was in good health more than one year after the operation.

It is interesting to note that among female patients the mortality of operation has been only 45 per cent., while among the male it is 57 per cent. In searching for an explanation of this marked difference, I have noticed that sarcomata were found one-third oftener in males than in females, and suppose that this fact may have something to do with lessening the mortality among women.

Most of the operations were on adults, nearly one-half being between thirty and fifty years of age. The extremes of life were nine years in a boy and sixty-five years in a woman. Those patients under twenty and over fifty gave the highest percentage of recoveries.

The average duration of symptoms before operation was two years and three months. In 12 patients symptoms had

existed for less than six months, in 11 for one year, in 8 for one year and a half, in 12 for two years, in 11 for three years, in 7 for four years, and in 6 for periods varying from four to eighteen years. The duration of symptoms does not, unfortunately, throw much light upon the nature of the tumor, since I find that the average duration of symptoms in the patients with sarcoma was two and three-quarters years, in those with adhesions two and three-quarters years, in those with echinococcus two and one-half years, and in those with fibroma one and a half years; while in all other forms of growth the average was about two and one-eighth years.

A history of injury is noted in only five cases,—three sarcomata, one each a psammoma and an endothelioma.

Of 82 cases in which the region of the spine affected is given, the upper dorsal region was involved in 33 cases, or over 40 per cent.; the tumor was found in the lower dorsal region in 24 cases, in the lumbosacral region in 14, and in the cervical region in 11 cases. As far as the results are concerned, it appears to be immaterial at what level the growth is found.

The cause of death is given in 28 cases. One-half of these were due to shock and hæmorrhage, or to infection and meningitis, there being 7 fatal cases under each of these categories. Eight patients died from exhaustion, three from recurrence of malignant growths, two from hypostatic pneumonia, and one from bed-sores and sepsis.

As regards the technique of the operation, it is essentially the same as when employed in traumatic cases. The patient lies in the prone position, with a sand pillow or other firm support beneath his shoulders and upper chest, so as to raise the diaphragmatic region somewhat away from the table; this position facilitates the operation by rendering the respiration of the patient less labored, as well as by making the spine more accessible. As has been repeatedly demonstrated at operation and autopsy, the inclination of the surgeon is to search for the growth too low down in the spinal canal. Horsley says it may be expected to be found four inches above the

upper limit of the hyperæsthetic zone. In the cases tabulated in this paper, the growth was not found in five; and in three of these it was proved, either at a second operation or at autopsy, that it could have been easily removed at the first attempt had the exploration of the spinal canal been carried higher. Some surgeons have advocated beginning the laminectomy some distance above the supposed location of the growth and then working downward, thinking that the wound would heal better thus than when the spine was explored from below upward, because by the latter procedure the parts divided have their nerve-supply impaired by the more highly situated lesion. But it seems to me that it is much more in accord with surgical principles to begin our operation where we expect to find the tumor, and to subsequently search the spinal canal higher up, if we fail to find the compressing structure where it is believed to be.

The incision should be made on the tips of the spinous processes, and should be amply large, to expose at least three vertebrae. I have never employed osteoplastic resection of the arches, known in Germany by Urban's name, and do not think it is a good form of operation. Sonnenburg condemns it, and attributes the death of one of his patients from meningitis on the eighteenth day to the presence of the retained bones. Nor do I think the plan advocated by Abbe (*New York Medical Record*, 1890, ii, 85) a commendable procedure. This surgeon makes his incision one-half-inch to the side of the spines, then chips them off just below the interspinous ligament, and turns them back with the soft parts as a flap on the other side of his wound, and then proceeds to do his laminectomy. For my own part, I think it better to cut right down on the spines, and then clear the laminae on each side with the scalpel and periosteal elevator. The bleeding during this process is always free, and can only satisfactorily be controlled by packing. Hæmostatic forceps will not hold in the fibromuscular tissues of the spinal gutters. It is most convenient, therefore, to pack one side temporarily while the other is being cleared, and then to pack the second side and return to complete the clearing of the first. By this means little blood is lost, and by the time the

spines and laminae are cleared the bleeding will have nearly ceased, without the employment of forcipressure, and without the application of a ligature. I have not found transverse division of the spinal aponeurosis at each end of the incision necessary to facilitate the retraction of the flaps; but it may be employed, if preferred.

In the dorsal region, where the spines overlap each other, the next step is to cut off two or three spines at their base with large Butcher's knife-bladed forceps. It is impossible to insert a forceps between the laminae until the spines are out of the way. When this is accomplished, it may be possible to bite through the bases of the laminae, next the pedicles, with large knife-bladed forceps. The blades should be set nearly at right angles with the shaft, the angle being on the edge, as in bandage scissors, not on the flat, as in the ordinary curved scissors. If such forceps are not at hand, or if they cannot be made to bite through the laminae, I prefer to apply a crown trephine to the base of one of the spinous processes, and thus open the spinal canal. The trephine should be at least a half or three-quarters of an inch in diameter. When the canal has once been entered, the opening may be enlarged with rongeur forceps. I do not think the use of chisel and mallet (a gouge is safer) advisable, as a rule, but have at times found them useful in trimming off the ragged margins left by the rongeur forceps.

Hæmorrhage from the spinal veins may be controlled by gauze packing or by Horsley's wax, which should always be at hand.

The condition of the dura should next be examined. A considerable amount of connective tissue may overlie it, and removal of this alone may be sufficient to relieve all symptoms, if no other cause of compression can be found. The dura should pulsate, and normally bulges somewhat into the wound, occluding the extradural space at the limits of the opening made into the bony canal. It is well to be quite sure that no extradural cause for compression exists before proceeding to open the membranes, since the risks of producing meningitis are thus considerably increased. Horsley's dural separator is, I think, the most convenient instrument to use in exploring the

spinal canal beyond the limits of the wound. Krause (*Deutsch. med. Woch.*, 1903, xxix, Ver.-Beil., 321) uses a thick sound to explore when the tumor is not found immediately beneath the opening in the spinal canal. If nothing can be detected by means of cautious exploration in this manner, the dura may then be opened in the median line. The incision should be made with a scalpel hitherto unused in the operation, and the same precautions to avoid injuring the cord are to be used that we employ when opening the peritoneal cavity to guard against injury of the intestines. The opening first made should be small, and the escape of the cerebrospinal fluid, which may prove a veritable flood, should not be allowed to take place too rapidly. No alarm need be felt at the quantity of this fluid evacuated, since, so far as I am aware, no evil results have been known to follow the plan usually adopted, of letting it run until it stops of its own accord. In an operation on the cervical region, Woolsey (*New York Medical News*, 1904, ii, 625) packed the subdural space at the upper end of the wound with gauze, to check the flow of cerebrospinal fluid before the operation was proceeded with; and he mentions the plan adopted by Schede of encircling the cord above and below the seat of operation with an extradural temporary ligature; but most surgeons have not been forced to adopt such measures to check the ooze.

The opening in the dura is then to be enlarged with scissors to the full extent of the laminectomy wound, and the search for the tumor continued. Almost invariably the tumor, whether intra- or extradural, is found to one side or other of the cord, and nearer its posterior than its anterior surface; but if it is not detected in these situations, the anterior surface of the cord may be cautiously explored with an aneurism needle.

If a cyst is found it should be punctured, and, especially in the case of hydatid cysts (which in all the cases here recorded were extradural), great care should be taken to prevent spread of infection. As a rule, the intradural tumors are found to be more or less encapsulated, and may be removed with only trifling hæmorrhage.

If no tumor can be found in the region of the spinal cord

exposed, the surgeon should not hesitate to remove the spines and laminae of three, four, or five of the vertebræ higher up. The chances of an error in diagnosis having been made are much less than those of failing to find the tumor through timidity of exploration. Of course, in these, as in all other cases, the extent of the operation must be governed largely by the condition of the patient; and in case of collapse of the patient the operation should be temporarily abandoned, and concluded after a day or two, if possible, when reaction has occurred, as was done in one case by McCosh, with the result that the tumor was found and removed at a higher level than that exposed at the first operation. Where no cause for the symptoms can be found, it is at least possible to divide the posterior roots of the affected nerves, and thus promote euthanasia.

If the dura has been opened, it should be sutured, if at all, very loosely. These patients have done much better when the drainage of cerebrospinal fluid after the operation has been free. Fine catgut is better than silk for the dura, as it is less liable to cause a persistent sinus. Drainage with gauze down to the dura should, I think, be employed in every case. The wound of the soft parts is extensive, and the traumatism will have been considerable; unless free exit is given to the wound discharges suppuration is quite apt to ensue. The gauze may be removed on the fourth or fifth day, or as soon as the patient is able to bear the necessary disturbance. The spinal aponeurosis should be brought together with buried sutures of chromicized catgut, and the skin should be approximated with interrupted sutures of silkworm gut, but not too closely applied.

After the operation no rapid improvement in the patient's condition need be anticipated; indeed, the paralysis and the anæsthesia are sometimes markedly aggravated by the interference with the spinal nerves. But the pain is nearly always remarkably relieved; and the patient is in a more hopeful frame of mind than before the operation.

The after-treatment should be the same as in every serious operation. Calomel and Dover's powder, as in head injuries,

will be beneficial to obviate the tendency to restlessness and wakefulness. The period of rest in bed must vary somewhat with the strength of the patient and with the extent of the operation. Some patients can be allowed to get out of bed in less than a week; but, as a rule, they should maintain the recumbent position for from three to five weeks. When the patient first gets out of bed, his back should be supported in a spinal brace or a plaster cast; and for the partial paralysis of his limbs, which sometimes persists, such orthopædic appliances should be ordered as may be required.

LIST OF CASES ANALYZED.

- Abbe. *Journal of Nervous and Mental Diseases*, 1903, xxx, 103. Variety of growth not stated; recovered.
- Abbe. *Thorburn*, *Brit. Med. Jour.*, 1894, i, 1403. Syringomyelia; no improvement.
- Abbe. *Starr*, *N. Y. Med. Record*, 1890, ii, 85, Case 6. Sarcoma; died.
- Abrahamson. *Journal of Nervous and Mental Diseases*, 1903, xxx, 102. Not stated; died.
- Anderson. *Ransom*, *Brit. Med. Jour.*, 1891, ii, 1144. Echinococcus; died.
- Barclay. *Clark*, *Brain*, 1895, xviii, 256. Endothelioma; died.
- Bottomley. *Munro*, *Jour. Amer. Med. Assoc.*, 1904, ii, 1183, Case 8. Adhesions; improved.
- Bruns and Kredel. *Archiv f. Psychiat.*, 1896, xxviii, 97, Case 1. Neurolog. *Centralbl.*, 1894, xiii, 281. Sarcoma; died.
- Bruns and Lindemann. *Archiv f. Psychiat.*, loc. cit., S. 133, Case 2. Neurolog. *Centralbl.*, loc. cit., S. 389. Sarcoma; died.
- Caselli. *Riforma Med.*, 1893, iv, 380. Osteoma; recovered.
- Chipault. *Dejerine and Spiller*, *Comptes Rendus de la Soc. de Biol.*, Paris, 1895, 10^e Série, ii, 622. Sarcoma; died.
- Crofts. *Horsley*, *Clin. Jour.*, London, 1896-97, ix, 183. Syringomyelia; improved.
- Curtis. *N. Y. Med. Record*, 1898, i, 346. Secondary carcinoma; died.
- Cushing. *ANNALS OF SURGERY*, 1904, i, 934. Fibrosarcoma; recovered.
- Davies-Colley. *Trans. Clin. Soc. of London*, 1892, xxv, 163. Sarcoma; recovered.
- Davis, George G. *Jour. Amer. Med. Assoc.*, 1904, i, 751. Sarcoma; no improvement.
- Deaver, J. B. *Lloyd*, J. H., *Amer. Jour. Med. Sc.*, vol. xcvi, p. 564. Adhesions; died.
- Elliot. *Putnam*, J. J., *Amer. Jour. Med. Sc.*, 1899, vol. cxxviii, p. 385, Case 3. *Journal of Nervous and Mental Diseases*, 1903, xxx, 665, Case 1. Sarcoma; great improvement.
- Elliot. *Putnam*, J. J., *Journal of Nervous and Mental Diseases*, loc. cit., Case 2. Carcinoma; died.

- Elliot. Putnam, J. J. *Journal of Nervous and Mental Diseases*, loc. cit., Case 3. Fibrosarcoma; died.
- Eskridge and Freeman. *Phila. Med. Jour.*, 1898, ii, 1236. Fibroma; recovered.
- Eskridge and Rogers. *Ibid.*, 1898, i, 332. Tumor of vertebræ; died.
- Faure. Hirtz and Delamere, *Bull. de la Soc. Méd. des Hôp.*, Paris, 1902, xix, 308. Endothelioma; died.
- Fenger. Church and Eisendrath, *Amer. Jour. Med. Sc.*, 1892, vol. ciii, p. 395, Case 6. Spindle-celled sarcoma; died.
- Fripp. White, *Hale, Trans. Clin. Soc. of London*, 1900, xxxiii, 140. Dermoid cyst; died.
- Gerster. *N. Y. Med. Record*, 1890, ii, 131. Putnam and Warren, *Amer. Jour. Med. Sc.*, 1899, vol. cxviii, p. 388, Case 9. Sarcoma; died.
- Gerster. Sachs, *N. Y. Med. Record*, 1900, i, 7, Case 2. Fibrosarcoma; improved.
- Graff. Schultze, *Mittheil. a. d. Grenzgeb. d. Med. u. Chir.*, 1903, xii, 153, Case 7. Fibroma; much improved.
- Graff. *Ibid.*, loc. cit., Case 9. Fibromata; died.
- Hahn. *Deutsch. Zeit. f. Chir.*, 1902, lxiii, 421, Case 1. *Centralbl. f. Chir.*, 1902, xxix, 399, Case 1. *Berlin. klin. Woch.*, 1902, xxxix, 645, Case 1. Echinococcus; died.
- Hahn. *Deutsch. Zeit. f. Chir.*, loc. cit., Case 2. *Centralbl. f. Chir.*, loc. cit., Case 2. *Berlin. klin. Woch.*, loc. cit., Case 2. Echinococcus; recovered.
- Hahn. *Berlin. klin. Woch.*, loc. cit., Case 3. Osteoma; recovered.
- Hahn. *Deutsch. Zeit. f. Chir.*, loc. cit., Case 5. *Berlin. klin. Woch.*, loc. cit., Case 4. Syringomyelia; died.
- Hartley. Fraenkel, *Journal of Nervous and Mental Diseases*, 1903, xxx, 101. Fibrosarcoma; died.
- Horsley. Gowers, *Trans. Med.-Chir. Soc. London*, 1888, lxxi, 377. Fibromyxoma; recovered.
- Horsley. *Brit. Med. Jour.*, 1890, ii, 1289. Table v. Not stated; died.
- Horsley. *Clin. Jour. London*, 1896-97, ix, 182. Echinococcus; recovered.
- Horsley. *Ibid.*, loc. cit., 183. Syringomyelia; improved.
- Ignatoff. *Vayenno Med. J.*, St. Petersburg, Sect. I, vol. clxxxvii, pp. 30-32; quoted by Putnam and Warren; *Amer. Jour. Med. Sc.*, 1899, vol. cxviii, p. 388, Case 13. Chondrosarcoma; improved.
- Israel, J. *Deutsch. med. Woch.*, 1902, xxviii, Ver.-Beil., 369; 1903, xxix, Ver.-Beil., 110. Chondromyxosarcoma; much improved.
- Krause. Sängers, *Münch. med. Woch.*, 1894, xli, 431. *Berl. klin. Woch.*, 1901, xxxviii, 583, Case 3. Sarcoma; died.
- Krause. Selberg, *Deutsch. med. Woch.*, 1902, xxviii, Ver.-Beil., 368, Case 2. Remak, *Berlin. klin. Woch.*, 1902, xxxix, 646. Angiosarcoma; died.
- Krause. *Berlin. klin. Woch.*, 1901, xxxviii, 541, Case 1. Psammoma; recovered.
- Kümmel. *Archiv f. klin. Chir.*, 1895, vol. 1, p. 452. Sarcoma; improved.
- Lennander. Henschen, *Upsala Läkaref. Forhandl. N. F.*, Bd. vi, p. 453, abstracted in *Centralbl. f. Chir.*, 1902, xxx, 935. Schultze: *Mittheil. a. d. Grenzgeb. d. Med. u. Chir.*, 1903, xii, 209. Fibrosarcoma; recovered.

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- Lloyd, S. Amer. Med. and Surg. Bull., N. Y., 1896, x, 659. Echinococcus; recovered.
- Lloyd, S. Collins, Journal of Nervous and Mental Diseases, 1903, xxx, 100, Case 1. Not stated; much improved.
- Macewen. Lancet, 1888, ii, 254. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 2. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 3. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 4. Adhesions; died.
- Macewen. Ibid., loc. cit., Case 5. Adhesions; died.
- Martin. Spiller and Musser, Trans. Coll. Phys., Phila., 1903, xxv, 1. Cyst; recovered.
- McCosh. Starr, Phila. Med. Jour., 1902, i, 288. Jour. Amer. Med. Assoc., 1901, ii, 569, Case 14. Fibroma; died.
- McCosh. Starr, Amer. Jour. Med. Sc., 1895, vol. cix, p. 613, Case 3. Jour. Amer. Med. Assoc., loc. cit., p. 626, Case 2 in Table II. Sarcoma; died.
- McCosh. Amer. Jour. Med. Sc., loc. cit., Case 5. Jour. Amer. Med. Assoc., loc. cit., Case 1 in Table II. Lipomata; died.
- McCosh. Bailey, Journal of Nervous and Mental Diseases, 1903, xxx, 99. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 11. Sarcoma or granulation tissue; recovered.
- McCosh. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 12. Sarcoma; improved.
- McCosh. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 13. Sarcoma; died.
- Mikulicz. Lichtheim, Deutsch. med. Woch., 1891, xvii, 1386. Psammoma; died.
- Mikulicz. Ibid., loc. cit. Psammoma; marked improvement.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 18. Putnam and Warren, Amer. Jour. Med. Sc., 1899, vol. cxviii, p. 388, Case 19. Sarcoma; died.
- Munro. Jour. Amer. Med. Assoc., 1904, ii, 1183, Case 10. Thomas, J. J., Trans. Amer. Neurolog. Assoc., 1901, xxvii, 182. Myeloma; much improved.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 17. Sarcoma; died.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 14. Cavities in cord; died.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12. Cyst; improved.
- Park. Putnam and Krauss, Amer. Jour. Med. Sc., 1903, vol. cxxv, p. 1. Sarcoma; much improved.
- Pescarolo. Verhandl. d. X. Internat. Med. Congr. (1890), Berlin, 1892, Bd. iv, Abth. ix, S. 9. Fibromyxosarcoma; not improved.
- Quensel and Garten. Neurolog. Centralbl., 1898, xvii, 482. Sarcoma; died.
- Raymond. Jour. de Neurol., Bruxelles, 1903, viii, 203. Sarcoma; died.
- Rehn. Laquer, Neurolog. Centralbl., 1891, x, 193. Lymphangioma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb. d. Med. u. Chir., 1903, xii, 153, Case 2. Deutsch. Zeit. f. Nervenhe., 1900, xvi, 114, Case 1. Verhandl.

- d. Gesellsch. deutscher Naturfor. u. Aerzte, 73 Versamml, zu Hamburg, 1901, ii, 100, Case 1. Fibrosarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 3. Deutsch. Zeit. f. Nervenhe., loc. cit., Case 2. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 2. Fibromyxosarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 5. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 3. Spindle-celled sarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 6. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 4. Angiosarcoma myxomatodes; died.
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STUDIES IN THE SURGICAL ANATOMY OF THE SMALL INTESTINE AND ITS MESENTERY.*

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THE "Studies" herewith reported concern that part of the small intestine which extends from the end of the duodenum to the ileocæcal valve, and which is known to anatomists as the "jejuno-ileum."

About two years ago I began certain investigations on the cadaver for the purpose of determining whether, when a loop of small intestine appears in an abdominal wound, there is any means by which the surgeon may get an approximate idea as to the part of the intestine which the loop occupies. After a careful examination of the gut and its mesentery in a large number of subjects to see if there were any points about the intestine or its mesentery which might serve to differentiate one part of the tube from the rest of it, a series of tests was conducted through various abdominal wounds on the cadaver for the purpose of finding out with what degree of success this information could be practically applied. To this process I gave the name, "Intestinal Localization." The results were sufficiently gratifying to justify me in thinking that the process was a practical one, and that it might be useful on the living subject. I therefore reported the results of these investigations to the American Surgical Association at the Annual Meeting, May, 1903.† While I was working on the subject of intestinal

* The Mütter Lecture for 1904, delivered at the College of Physicians of Philadelphia, December 2, 1904.

† They were published in the Transactions of the Association, and also in the ANNALS OF SURGERY for October, 1903. Since making this report, I have had good reason to believe, both from my own experience and from that of other surgeons who have kindly communicated their results to me, that the method may be of great use on the living subject whenever

localization, I noted incidentally certain other directions in which investigations might be made with a fair promise of good results. I therefore conducted a new series of studies on the cadaver, this time, however, more in reference to such points of general surgical interest as might develop in the course of the work than to the subject of intestinal localization. In these studies * I was most efficiently assisted by Drs. W. E. Faulkner, D. D. Scannell, and W. C. Howe, as well as by several other physicians, and it gives me pleasure to acknowledge here my indebtedness to them.

The studies, which are necessarily somewhat fragmentary, are embraced under the following headings:

1. The length of the intestine, as measured from the end of the duodenum to the ileocaecal valve.
- ✓ 2. The length of the mesentery, as measured from the mesenteric root to different parts of the intestine.
3. The distance to which the different loops of the intestine may be drawn downward in the median line towards the pubes; results of tests.
4. Relative functional value of jejunum and ileum; resection of portions of ileum.
- ✓ 5. Demonstrations of the real shape of the mesentery.
6. Disposition of the mesentery in the abdominal cavity.
7. *The pelvic fold of the mesentery*; how to palpate it: its use as a landmark.
8. How to find the lower end of the ileum through an abdominal wound.
9. Influence of the mesentery on the course of the intestine:

it is desirable for the surgeon to know quickly what part of the intestinal canal a given loop occupies.

* Of the material used in this work, a part belonged to the Surgical Department of the Harvard Medical School; the remainder was kindly furnished by the Anatomical Department of that institution, and by the Pathological Department of the Boston City and of the Long Island Hospitals. I wish here to thank Drs. Thomas Dwight, F. B. Mallory, and G. B. Magrath, who represent the last three departments mentioned, for their courtesies in allowing me the use of it.

(a) Influence of the mesentery on short segments of intestine.

(b) Influence of the mesentery on longer segments of intestine.

(c) Kinks in the intestine.

10. Course of the intestine as affected by conditions within the abdomen.

11. Distention of intestines; experiments in the introduction and removal of air and water.

12. The passing of instruments into an enterostomy opening.

13. The determination of the real direction in a loop of bowel.

14. Conclusions.

The drawings were made from specimens, or from photographs, or from both.

THE LENGTH OF THE JEJUNO-ILEUM.

In the course of these investigations I made a number of measurements of the length of the jejuno-ileum, but, as similar measurements have already been made by a number of other investigators, I shall dismiss the subject in a few words. In thirty-one adult cadavers, of both sexes and of different nationalities, where the intestine was measured *in situ*, the average length was a little less than 23 feet (7.01 metres), the shortest being 14 feet (4.27 metres) and the longest 33 feet 10 inches (10.31 metres). All these measurements, with the exception of two, or possibly three, at the very beginning of the work, were made with a tape-measure, the intestine being *in situ*, and the abdominal cavity freely laid open from ensiform cartilage to pubes.*

Remarks.—Because of the fact that a long tube like the intestine, which can be so easily stretched, does not readily

* In twelve other cadavers, also of both sexes and of different nationalities, where the intestines were kindly measured for me by my colleagues and others, the same method being used, the average length was found to be a little less than that given above.

lend itself to so exact a process as that of accurate measurement, and also because in the process of measurement so many other sources of error may enter, I am of the opinion that statements made in text-books and elsewhere aim at an exactness which the facts do not justify. The average length of the small intestine of the adult (measured from the end of the duodenum to the ileocaecal valve) is probably somewhere between 21 and 23 feet (between 6 and 7 metres). The fact that the intestine varies greatly in length in different individuals, interesting as it may be, does not, however, especially concern the surgeon, except that a long intestine means more loops and a more complicated arrangement of coils, and that from such an intestine greater lengths of ileum may be resected without danger of interfering with nutrition than from a shorter one.

In connection with this subject, it is well to bear in mind, where the intestine is measured *in situ*, the great difference between the length of the gut when the measurement is made along its free border as compared with that made along its attached or mesenteric border. Thus, in one case in my series, while the gut along its free border measured about 20 feet (6.10 metres), it measured only 15 feet (4.57 metres) along its mesenteric border, showing a difference of 5 feet (1.50 + metres) between the two measurements. The free border of the gut is therefore much longer than the mesenteric border, and the free border may therefore appropriately be called the "long side" of the gut and the mesenteric border its "short side."

THE LENGTH OF THE MESENTERY.

On account of the usefulness in a general way of knowing the distance to which the various parts of the intestinal tube may reach in different directions within and without the abdominal cavity, I have measured the length of the mesentery at different distances down the intestine. The measurements were taken from the attachment of the mesentery on the pos-

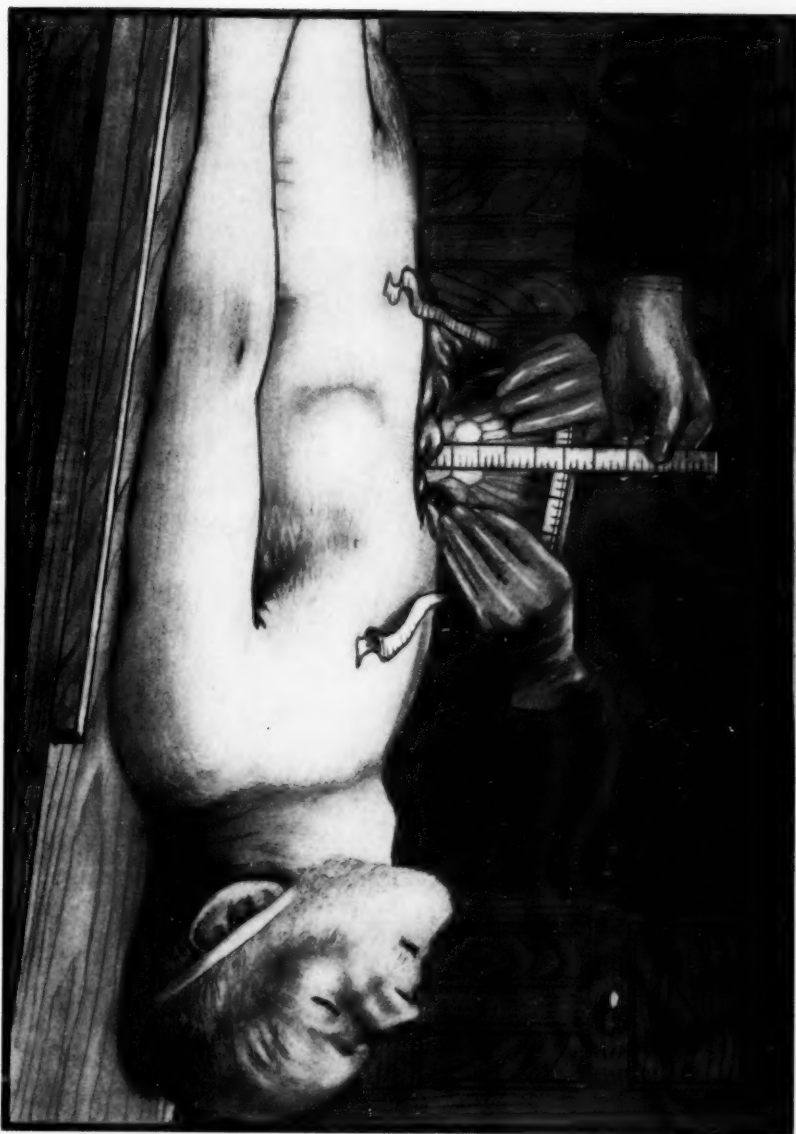


FIG. 1.—Showing the method for determining the length of the mesentery at different points along the intestine (usually at every foot) from the end of the duodenum to the ileocecal valve. One hand of the assistant is shown. His other hand held the ruler in exact contact with the mesenteric root, but, for the sake of simplicity, this hand was omitted in the illustration. (Drawn from the cadaver and from a photograph.)

terior abdominal wall to the edge of the mesentery where it is attached to the intestine. The method I employed for taking these measurements—and this was done on twenty cadavers—is shown in the accompanying illustration (Fig. 1).

Results.—The results of these measurements show, as far at least as we can judge from twenty cases, that:

(1) As a rule, the length of the mesentery gradually increases from the end of the duodenum up to the fourth or fifth foot of the gut, at which point it usually reaches its maximum. Occasionally it reaches its full length even earlier. Opposite the lower end of the gut, the length of the mesentery diminishes again, rather more abruptly than is the case opposite the upper end of the canal.

(2) Throwing out of consideration the upper and lower extremities of the mesentery, that structure varies, as a rule, from 5 to 7 inches in length (13 to 18 centimetres), the extremes being about $4\frac{1}{2}$ inches and 8 inches ($11\frac{1}{2}$ centimetres and $20\frac{1}{2}$ centimetres).*

(3) Short mesenteries are usually short throughout and long ones usually long throughout; all, however, showing some variations in length in the course of the canal.

(4) As a rule, it may be said that the longer the intestine the longer the mesentery, and the shorter the intestine the shorter the mesentery, though there are marked exceptions to this rule.†

* This result differs from that given by Treves, who says: "The length of the mesentery from the spine to the intestine varies in different parts of the canal; its average length may be taken as between eight and nine inches." As my own measurements show the average to vary between five and seven inches, I can explain the disagreement only on the assumption that possibly, in speaking of the length of the mesentery, Treves included the width of the gut also, for, if this were so, the two averages would more nearly agree.

† In one intestine which measured 30 feet 8 inches (9.35 metres), at only one point did the mesentery reach the length of 6 inches ($15\frac{1}{4}$ centimetres); while in another intestine, which was only 14 feet long, the mesentery measured 6 inches at several points.

THE DISTANCE TO WHICH DIFFERENT LOOPS OF THE
INTESTINE MAY BE DRAWN DOWNWARD IN
THE MEDIAN LINE.

For the sake of determining roughly the relative mobility of the different parts of the small intestine in a downward direction, I have made a number of measurements on cadavers. These measurements rather suggest the probability that it must be unusual for a loop in the upper part of the tube to occupy a position in the lower part of the abdomen or in the pelvis. Conversely, as I have ascertained by drawing loops from the lower part of the tube upward, it is probably also unusual for one in the lower part of the tube to occupy a region high up in the abdomen. This general rule, to which, however, there may be occasional and marked exceptions, is of use in giving us a certain amount of information as to what loops we are most apt to meet through an incision in one or the other of these two regions.

Sixteen subjects in all were used, and in each subject a loop of intestine was drawn down at every foot, and the measurement taken. It was found more convenient and exact for purposes of comparison to take the measurements *upward* from the level of the pubic spine to the various loops as they were drawn downward one after another. The method used is shown in Fig. 2. The abdomen has been freely laid open from ensiform cartilage to pubes.

Results.—Summarizing the results, I find that:

(1) Taking the loops in succession, from above downward, each, as a rule, reached a little lower than the preceding one.

(2) A loop from the first foot of the jejunum could, on the average, be drawn to a point about 3 inches ($7\frac{1}{2}$ centimetres) above the pubes. The extremes were $\frac{1}{2}$ inch ($1\frac{1}{4}$ centimetres) and $4\frac{1}{2}$ inches ($11\frac{1}{2}$ centimetres).

(3) In all but one of the subjects the pubes was reached by some part of the intestine. This usually did not occur before the tenth foot of the canal had been brought down.

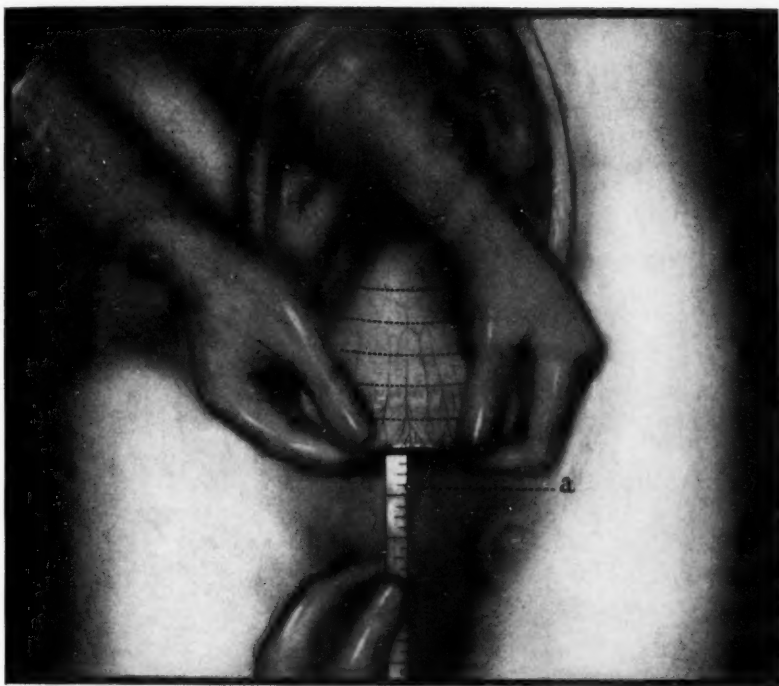


FIG. 2.—Showing the method of determining the point above the pubes to which a loop of small intestine will reach when gently drawn downward. The measurement is taken upward from the level of the spine of the pubes (a) to the free border of the intestinal loop. The dotted lines on the intestine and mesentery are arbitrary lines, indicating the levels of certain intestinal loops which do not reach so near to the pubes as does the loop shown in the illustration.

(4) As for the frequency with which the free edge of the intestine reached *below the pubes*, my measurements in these sixteen cadavers showed that in about two-thirds of the cases the free edge of some part of the gut reached a point which varied from 1 to 3 inches ($2\frac{1}{2}$ to $7\frac{1}{2}$ centimetres) below that landmark.

RELATIVE FUNCTIONAL VALUE OF THE JEJUNUM AND ILEUM; RESECTION OF PORTIONS OF ILEUM.

One can hardly fail to be impressed with the idea that the ileum, or at least the lower part of it, is apparently of less functional value than the jejunum. When one puts a coil from the jejunum beside one from the ileum and studies these two loops and the characteristics of the attached mesentery, one is struck with what seems to be the superior arrangement, for functional activity at least, of the upper to that of the lower segment of gut. The jejunum is usually thick and muscular, is filled with large and numerous valvulæ conniventes, and is evidently supplied with a great deal of blood, since the blood-vessels of the mesentery are large and straight and possess comparatively few branches. The ileum, on the other hand, is generally thin and flabby, and its valvulæ conniventes, if indeed there are any present, are smaller and less numerous than those of the jejunum, while the small, tortuous, and frequently branching vessels of its mesentery suggest a poor blood supply and a correspondingly low degree of functional activity. Judging from these facts, and from the numerous cases in which good results have been obtained after resection of appreciable lengths of the ileum, it may be assumed that a large portion of the lower part of the small intestine may, apparently, be sacrificed without detriment to health. I know of the case of one patient, a gentleman of thirty-three years, from whose ileum about three years ago nearly 8 feet (2.44 metres) of the tube was resected, recovery resulting.* I know this gentleman

* This case was reported by George R. Harris, M.D. (of Norwich, Conn.), in the Medical Record, October 11, 1902.

personally, and I recently had a talk with him about his case. He said that he felt perfectly well,—better, in fact, than he had for years before the operation; that he was able to digest his food without discomfort; that he was no longer troubled with constipation and headache, which had formerly annoyed him; that he had lost no weight, and that he was quite as able to do his work (he is a sculptor by profession) as he had been before the operation. His only complaint was on account of occasional diarrhœa.* Many other cases of resection of large portions of the ileum have recently been reported, usually with results which were entirely satisfactory.

From all this it would appear that the removal of a large portion of the ileum, for sufficient reasons, is perfectly justifiable; provided, of course,—and here is the danger in resecting large portions of an intestine,—that a sufficient length of intestine is left to carry on nutrition properly. In this connection, it is interesting to observe that the ileum, which, as far as we can now see, is the least valuable part of the small intestine, is far more frequently the seat of pathological lesions than is the jejunum.

THE REAL SHAPE OF THE MESENTERY; DEMONSTRATIONS IN SITU; THE TWO PORTIONS OF THE MESENTERY.

The mesentery is a flat structure, whose root is about 6 inches ($15\frac{1}{4}$ centimetres) long, and whose free border, which extends from one end of this root to the other, averages from 21 to 23 feet ($6.40 +$ metres to $7.01 +$ metres) in length, while the distance from the base of the mesentery to its free border at any one point is usually not more than 7 inches (18 centimetres). It is clear that a satisfactory demonstration of such a structure *in situ* is not possible by the ordinary methods.

* It occurred to me that perhaps this so-called "diarrhœa" might really be the result of the fact that the loss of so much absorbing surface necessitated the retention on the part of the intestinal contents of more than their usual amount of watery constituents.

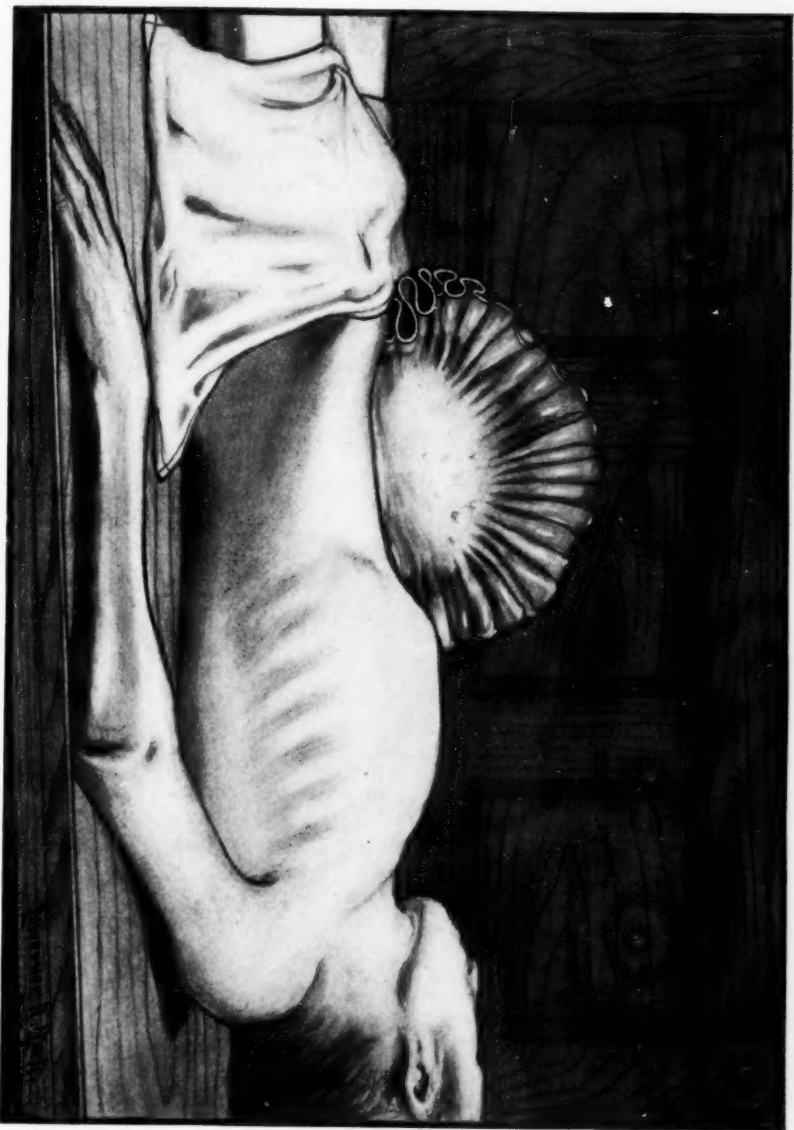


FIG. 3.—Showing the intestinal tube thrown into alternate curves, which are held in place by means of a stout copper wire within the gut. The alternating arrangement of the loops is most evident near the lower end of the ileum. The mesentery is flat up to the place where the ruffled edge begins. (Drawn, with slight modifications, from a photograph.)

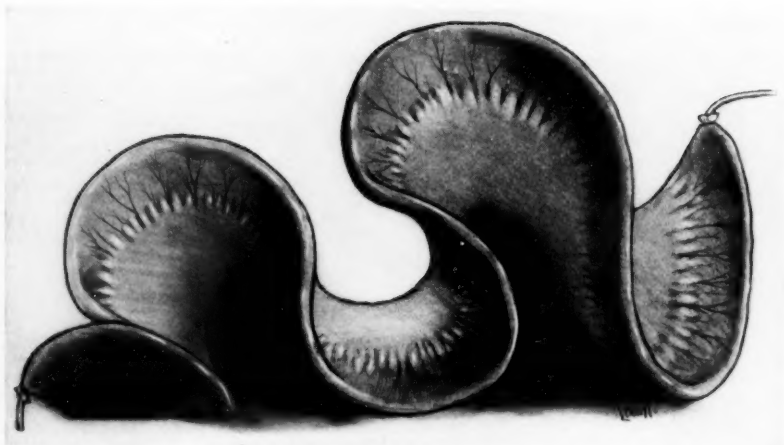


FIG. 4.—Showing *in situ* from above a portion of the intestine with its attached mesentery. It is thrown into large curves, and held there by means of a stout copper wire within the lumen of the gut. (Drawn from the specimen and from a photograph.)

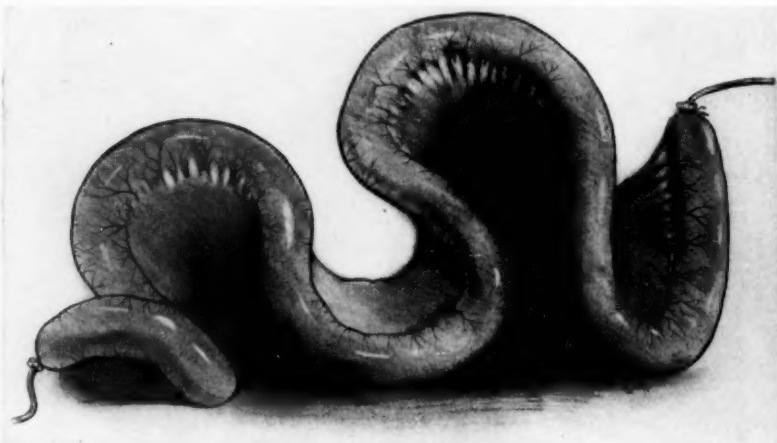


FIG. 5.—The same specimen shown in Fig. 4, with the bowel somewhat inflated.

In my paper on "Intestinal Localization" I tried to simplify its demonstration by introducing a small dowel into the lumen of the gut, about 8 inches (20 centimetres) from the ileocaecal valve, and, after "gathering up" the entire tube on it in the same way that an earthworm is drawn upon a hook, I caused the intestine and mesentery to assume a straight line. This can usually be done on intestines of moderate length and thickness where there is not too much fat in the mesentery.

By means of this contrivance I was able not only to demonstrate the entire mesentery and small intestine, but also, by turning the rod to the left or to the right side of the abdomen, to give an opportunity of inspecting and comparing the right and left fossæ of the abdomen with the greatest ease.

This demonstration, I thought, made the shape of the mesentery somewhat clearer; but still the folds in the distal parts of the mesentery and the gathers in the gut itself made it evident that it would be quite impossible to represent all the parts on the same plane. I therefore devised the scheme of running a stout copper wire through the intestine, bending it into continuous curves, which were made to alternate from one side of the mesentery to the other, in this way "taking up all the slack," as it were. I was able therefore to show simultaneously the whole of the mesentery and the intestine spread out without folds (Fig. 3).

In Fig. 4 another experiment with copper wire within the intestine is shown. Only a portion of the gut is here used. The point of view, being different from that in Fig. 3, gives a rather better idea of the course of the intestine and the attached mesentery. The curves are much longer than those in Fig. 3.

Another illustration (Fig. 5) shows the portion of intestine and mesentery represented in Fig. 4, the bowel having been distended with air.

From these demonstrations, it is quite evident not only that the distance between the two ends of the mesenteric root increases considerably the farther we take our line out on the

mesentery towards the gut, but also that this rate of increase, while gradual at first, suddenly becomes very marked after the ruffled border of the mesentery has been reached. In order to determine roughly, in figures, the rate of this increase, I made some measurements of the relative lengths of the mesenteric root, of the mesentery close to the bowel, and of the mesentery half-way between these points. In order to establish this middle line, I measured the length of a mesentery *in situ* at every foot of the intestine, in the manner already described, determining, however, at each foot of the intestine the point on the mesentery which indicated one-half of the distance between the root of the mesentery and its intestinal border. At each point thus determined I tied a knot of silk and cut off the ends. I then had a line of knots, running from above downward, exactly half-way out on the mesentery. I now measured the mesentery along these knots, proceeding carefully from one to another. I also measured the length of the root of the mesentery, and of the mesentery at its insertion into the bowel. The following are the figures:

Length of mesenteric root, 6 inches (15 centimetres).
Length of mesentery half-way between the mesenteric root and the intestinal border, 23 inches (58 centimetres). Length of mesentery at bowel, 13 feet 8 inches (4.16 metres).

Expressed in other terms, which assume the length of the mesenteric root to be one unit, the measurement of the mesentery half-way to the gut was 4 units, and the measurement of the intestinal edge of the mesentery 27 units. These figures give an idea as to the enormous increase in length which takes place in the outer half of the mesentery. It does not require much inspection of the parts to realize that almost all of this great elongation really takes place in the outer one-third or one-fourth of the mesentery, that is, from the beginning of the ruffling of the mesenteric border. The mesentery, therefore, may well be described as consisting of two portions:

(1) *A proximal or flat portion*, comprising that part of the mesentery (about two-thirds or three-fourths of it) which

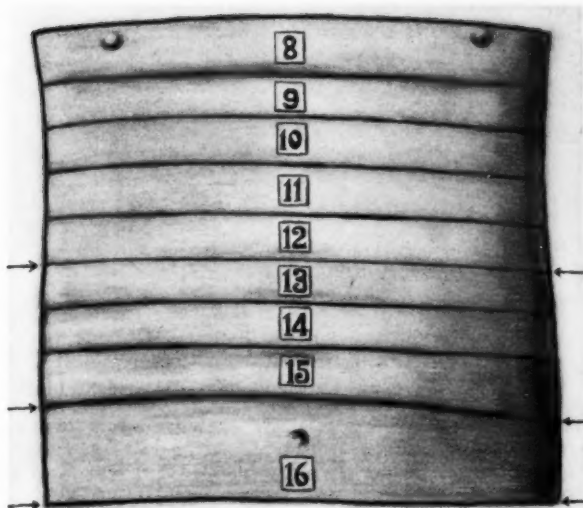


FIG. 6.—Showing *in situ* the sections of the trunk of an adult male. The two nipples and the umbilicus are the only landmarks. Arrows indicate the three sections to which reference is made in the text. (Drawn from a photograph of all the sections *in situ*.)



FIG. 7.—Showing the upper side of section No. 13. The mesentery, indicated here as in the other drawings by a thick white line, sweeps boldly towards the left side of the subject. (Drawn from the specimen.)

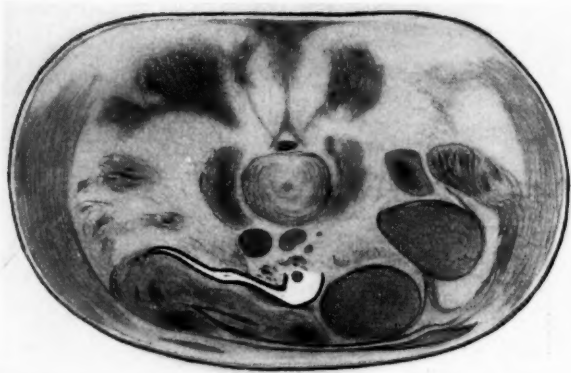


FIG. 8.—Showing the upper side of section No. 16, which is cut slightly out of line. This section is at a level less than an inch above the umbilicus. The main sweep of the mesentery is towards the right side of the subject. Other sections of the mesentery appear at this level, but they are apparently distal portions from that part of the mesentery which rises higher up in the abdomen. (Drawn from the specimen.)

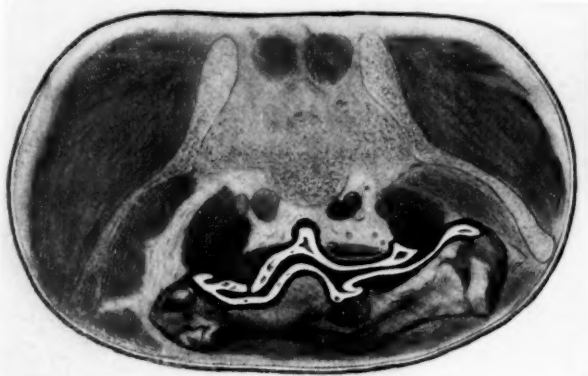


FIG. 9.—Showing the under surface of section No. 16. Because of the fact that below this level the sections were cut vertically and many of the parts had therefore fallen out, the under surface of section No. 16 was reversed so as to correspond with the drawings of the other two sections, and it was therefore assumed that this reversed section represented the upper surface of what would have been section No. 17, had the cutting of horizontal sections down the body been continued. This section is below the level of the lower end of the mesenteric root, which end was easily found on the specimen by opening up the spaces. Several sheets of mesentery are here seen. They are very irregularly disposed and twisted, and, of course, correspond with the coils of ileum which descend into the iliac regions and pelvis. (Drawn reversed, as described above, from the specimen.)

lies between the mesenteric root and the somewhat indefinite line where the ruffled border begins. This line might with propriety be called "the base of the ruffled border of the mesentery."

(2) *A distal portion, or "ruffled border"* (comprising the remaining one-third or one-fourth of the mesentery), which lies between the proximal or flat portion of the mesentery and the intestine.

DISPOSITION OF THE MESENTERY IN THE ABDOMINAL CAVITY.

Inasmuch as the length of the mesentery increases the farther out we remove our line from the mesenteric root, it is evident that, in order to accommodate itself to the restricted space allowed for it in the abdomen, the mesentery must be thrown into curves or folds. These folds must become more and more numerous the farther we remove our line from the mesenteric root. This tendency in the mesentery to assume the shape of curves or folds is repeated in the intestine in a manner which we shall see later. In addition to such investigations as I have been able to make on this subject on the ordinary cadaver, I have, realizing the great difficulty of getting accurate observations, carefully examined in reference to this point a series of frozen sections of a male adult, which belongs to the Anatomical Department of the Harvard Medical School, and, with the kind permission of Dr. Dwight, Professor of Anatomy, have reproduced three of them in which is emphasized the distribution of the deeper parts of the mesentery. Fig. 6 is drawn from a photograph of the body before the sections were taken apart, and Figs. 7, 8, and 9 show three of the sections, these being the only ones in which the mesentery could be distinctly made out. In order to understand these sections, it is best to imagine that the observer stands in front of the trunk, and that he looks down upon each section as those above it are removed.

While these sections belong to only one individual, yet the

evidence which an examination of them furnishes, so far as it goes, is of value, if only to illustrate the tendency of the mesentery to alternate in its direction, first to one side of the abdomen and then to the other. It is evident that in this individual the mesentery was first directed to the left, and lower down to the right. Below this its course cannot be clearly made out; but the third section shows two broad sheets in contact with each other, which extend from one side of the pelvis to the other.

Before leaving this subject, I should like to call attention to the fact that, as the sheets of the mesentery in the upper part of the abdomen leave their line of attachment at the mesenteric root in a direction more or less at a right angle with that root, these sheets are apt to be much flatter than those below, which, pursuing a course more or less parallel with the mesenteric root, show a much greater tendency to lie in folds.

THE PELVIC FOLD OF THE MESENTERY; HOW TO PALPATE IT; ITS USE AS A LANDMARK.

That part of the mesentery which descends into the pelvis from the lower end of the mesenteric root can usually be felt distinctly by the examining finger. It is somewhat singular that no allusion, so far as I have been able to discover, is made in surgical literature to the fact that this part of the mesentery can be so easily palpated through a wound in the lower part of the abdomen. I have ventured to give to this fold the name, "the pelvic fold of the mesentery," and I think the fitness of this name will be evident to any one who hooks his forefinger around it. On numerous occasions I have felt this fold on the cadaver, and not infrequently on the living subject. It seems to me that it is of distinct use as a landmark, for, whenever we wish to enter the great fossa on the left side of the mesentery, we have only to push our finger around it. On at least six occasions I have guided the tip of the irrigating tube around it to the left side of the abdomen,



FIG. 10.—Showing the forefinger rounding the lower end of the ileum to reach the left side of the mesenteric root. The ileum and its mesentery are held up, so that the finger-tip may be seen.

and have thus satisfactorily flushed out that great cavity. The cases in which this was done were cases of general peritonitis following appendicitis. The presence of this "pelvic fold" may also assist the surgeon in finding the lower part of the ileum, a procedure which will be considered in detail under the next heading.

HOW TO FIND THE LOWER END OF THE ILEUM THROUGH AN ABDOMINAL WOUND.

Knowing how important it may be for the operator in cases of suspected typhoid perforation, and in some cases of appendicitis, to find at once and without difficulty the lower end of the ileum just before it enters into the cæcum, I have devised a method which I have frequently used with success, at least on the cadaver. The technique of this procedure consists in carrying the forefinger over the psoas muscle and the iliac vessels, keeping the finger-tip close to the parietal peritoneum, and so entering the pelvis. The finger is then turned on its own axis and hooked upward, the peritoneum at the back part of the pelvis being followed carefully. In this procedure the finger usually goes behind the ileum, entering the cavity on the left side of the mesentery, where the finger comes against the lower end of that structure. The thumb and forefinger then close upon each other, grasping what is between them. When this is brought from among the coils of intestine, it will generally be found that it is a loop of the ileum, quite close to the ileocæcal valve. It is quite easy to do this, and to do it rapidly, in case the last part of the ileum hangs in the pelvis (Fig. 10). When, however, it lies above the ileocæcal valve, which appears to be the rule in about 50 per cent. of all cases, the manipulation just described is not always successful. A little practice on the cadaver, however, will usually enable one to trace out the lowest part of the ileum from its mesentery at the lower end of the mesenteric root.

INFLUENCE OF THE MESENTERY ON THE COURSE OF
THE INTESTINE.

It seems to me that the effect of the mesentery as a factor in determining the course of the intestine is hardly recognized as fully as it ought to be. While, as we all know, there are a number of influences which may affect the course of the intestine,—such as peristalsis, pressure from other viscera, distention by gas or other contents, etc.,—yet all these influences apparently have less effect upon the course of the intestine than has the mesentery.

Influence of the mesentery on short segments of intestine; it curves the intestine into a single loop.

That the intestine itself, freed from its mesentery, is straight, or nearly so, is easily proved. We remove from the cadaver a piece of ileum, say a foot or so in length, and carefully take away all the mesentery from it. If we then hold it horizontally between the thumb and fingers of both hands (as shown in Fig. 11), we see that it is quite straight.

If we now remove the mesentery from a corresponding piece of jejunum, and use the same test as that described above, we shall find that this segment of intestine, though not entirely straight, becomes nearly so (Fig. 12).

Now that we have shown the intestine, freed from its mesentery, to be straight, or nearly so, it remains to be demonstrated that it is the mesentery which, when it is attached to the intestine, prevents the latter from assuming a straight line, and obliges it to take a curved course. If a piece of ileum, like that shown in Fig. 11, is removed from the abdomen, with its mesentery still attached, it will be found quite impossible to straighten it on account of the restraining influence of the mesentery which keeps it curved (Fig. 13).

The concavity of the curve in this segment of intestine is on its mesenteric border, and the convexity is on the free border. There are other curves to which the intestinal tube is subject. These will be referred to later.

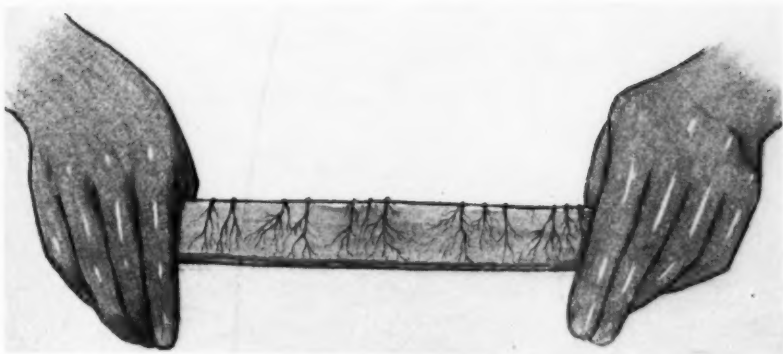


FIG. 11.—Showing a section of ileum from which all the mesentery has been carefully removed. The traction used is only enough to keep the upper line (the mesenteric border) of the gut straight; in other words, just sufficient to overcome the natural sag of that line. The gut is seen to be perfectly straight. (Drawn directly from the specimen.)

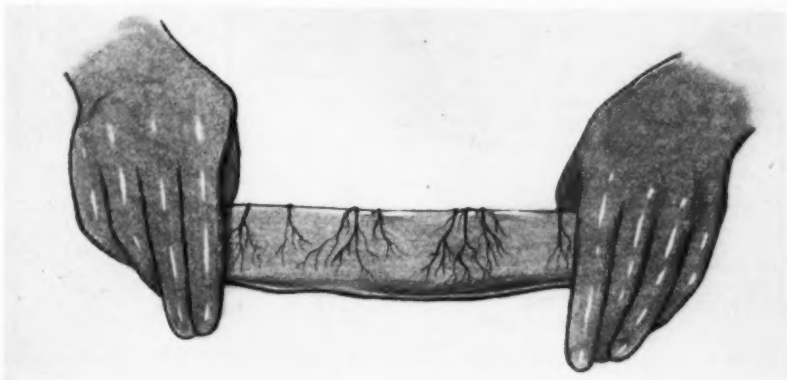


FIG. 12.—Segment of jejunum from the same subject which furnished the specimen shown in Fig. 11. This segment of intestine, though not perfectly straight, is nearly so.

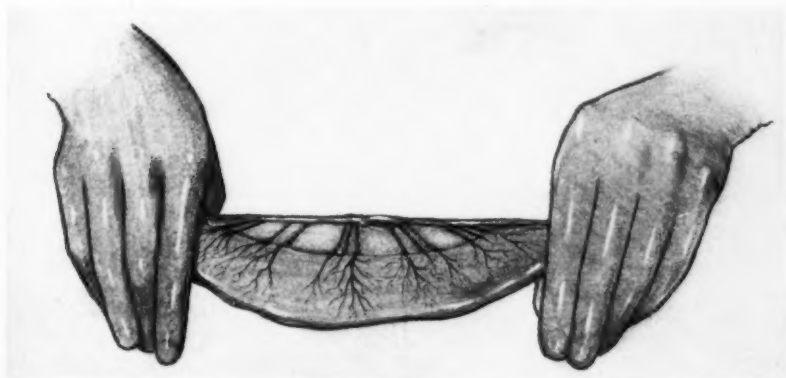
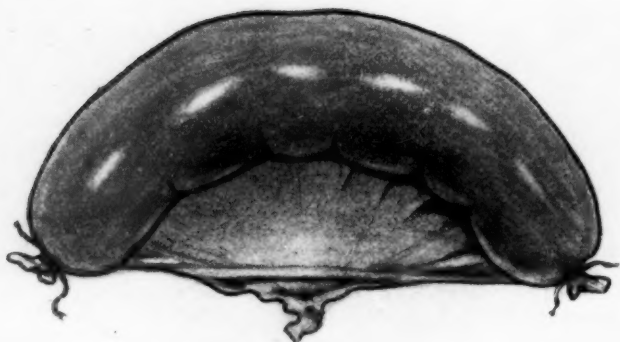


FIG. 13.—Representing the attempt to straighten the same piece of ileum shown in Fig. 11 before its mesentery was removed. The gut cannot be straightened, owing to the restraining influence of the mesentery which keeps it on a curve. The concavity of this curve is on the mesenteric border of the gut, and the convexity on its free border. It is quite obvious from this figure why the length of the entire intestine is so much greater when the measurement is made along its free border than it is when made along its attached or mesenteric border.



a



b

FIG. 14 (a).—Showing a short segment of intestine closed at the ends and distended with air. The V-shaped piece of mesentery is still attached. The gut is strongly curved, and traction lines appear across the mesentery, suggesting a tense bowstring. (Drawn from the specimen.)

FIG. 14 (b).—Representing the same segment of inflated intestine shown in Fig. 14 (a). Section of the mesentery at right angles to the line of traction along its base has caused the intestine to assume a straight course. (Drawn from the specimen.)

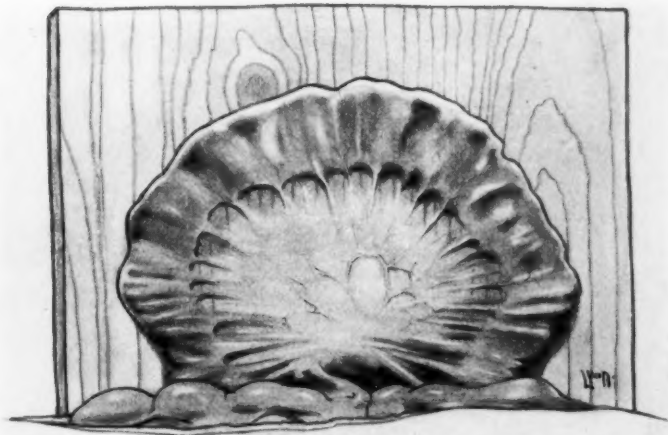


FIG. 15.—Exhibiting a loop of small intestine which has just been drawn out of an abdominal wound. The transverse lines across the base of the mesentery are lines of traction, brought into prominence by the attempt to straighten the tube. The hands drawing the specimen apart at the two sides are omitted intentionally. (Drawn partly from the specimen and partly from a photograph.)

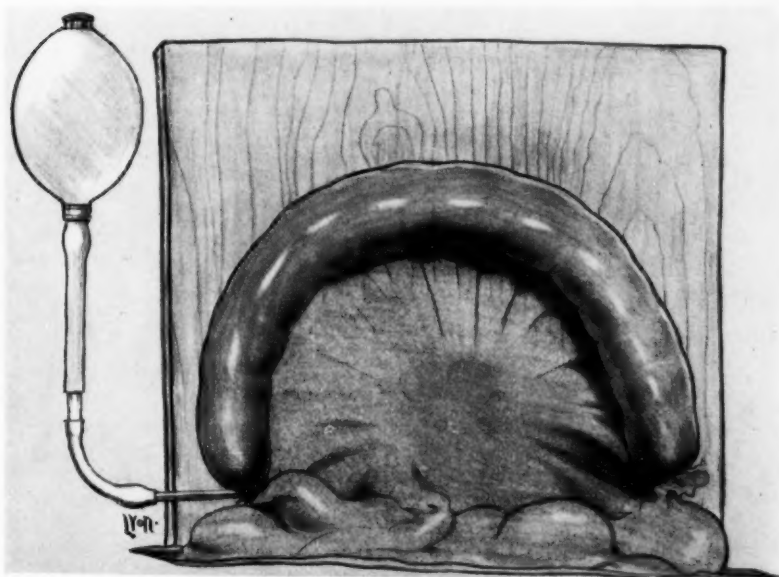


FIG. 16.—Showing distention with air of the same loop as is shown in Fig. 15. The ruffled border of the mesentery is stretched. (Sketched from specimen and from a photograph.)



FIG. 17.—Showing the intestine still further inflated with air. The two ends of the loop are closely approximated. That part of the mesentery just inside the loop is stretched, while in the centre is a depression which is continued into a gutter running to the deeper parts of the mesentery.



FIG. 18.—Exhibiting the appearance of the distended loop of bowel and its attached mesentery, shown in Fig. 17, as seen from the rear. That part of the mesentery which is nearest the bowel is tense and flattened, while the rest of the mesentery is continued downward from a point near its centre into the abdominal cavity. (Drawn from the specimen and from a photograph.)

The restraining effect of the mesentery is clearly seen in the following experiment. We tie up the two ends of a small segment, say six inches, of intestine, and then inflate it, the V-shaped piece of mesentery to which it corresponds remaining attached. The result will be that the distended intestine will appear curved like a bow. Traction lines, suggesting the string of the bow, will be seen on the mesentery (Fig. 14, *a*).

Let us now divide the mesentery on a line at right angles to the line of traction. When this is done, the tube instantly assumes a straight course (Fig. 14, *b*).

From this it seems likely that, while the mesentery corresponding to a piece of inflated intestine which is as long as six inches can curve the gut appreciably, the mesentery belonging to one-half of this length of tube cannot prevent the tube from assuming its natural direction, that is, a straight line.

The effect of the mesentery in obliging the bowel to take a curved course is also clearly seen when a somewhat longer loop is drawn from an abdominal wound, and an attempt made to straighten it. This is well shown in Fig. 15. When one inflates this loop with air, its curve becomes somewhat exaggerated (Fig. 16).

When this loop is still further inflated, the ends tend to come nearer together. That part of the mesentery corresponding to the ruffled border is very tense, except on that side which corresponds to the gap between the ends of the bowel, where a loose gutter-shaped depression runs down towards the base of the mesentery. From an inspection of this specimen (Fig. 17), it is evident that the intestine is curved by the tense mesentery, which appears to act on the loop of gut in the same way that tense cords from one part of the gut to another would act.

On lifting up this specimen and suspending it so that the distended loop of bowel is horizontal, and, viewing it from behind, the tense part of the mesentery which lies next the bowel is also horizontal, while the narrow neck of the mesentery reaches downward into the abdominal cavity, and we see

that the whole specimen presents a certain resemblance to a mushroom (Fig. 18).

Although it is not at once evident why the inflation of an intestinal loop causes the mesentery to assume this peculiar shape, yet after a little thought the reason will be clear. The horizontal and tense portion of the mesentery is the elongated "ruffled border of the mesentery," and the comparatively loose and vertical portion belongs to the deep, or proximal, part of the mesentery.

One other noteworthy thing about these inflated loops is a rotation of the bowel on its own axis, which slowly takes place while the air is being injected. The concavity of the curve of the bowel changes to one of the lateral aspects.

Influence of the mesentery on longer segments of the intestine; the bowel is made to assume a serpentine course made up of alternating loops. We have seen that, with the help of stout copper wire within the lumen of the intestine, we can cause the intestine to assume a course made up of alternating curves; but we have not yet determined whether such a course is a natural one on the part of the intestine. We know, of course, because of the shape of the ruffled edge of the mesentery, and also because of the fact that the intestine, at least its free border, is even longer than the intestinal edge of the mesentery, that the intestine must be thrown into coils, but we do not yet know that these coils have a tendency to alternate, first on one side of the mesentery and then on the other. A glance, however, at Fig. 19, which shows this tendency in a collapsed strip of gut hanging from the two ends of its ruffled border (the rest of the mesentery having been removed), and at Fig. 20, which shows this tendency still more marked when the same piece of gut is inflated, will be fair proof that such is the case.

For the next experiment a piece of bowel about two feet long was isolated by placing a ligature around each end of it. This isolated bowel was then inflated, when at once it sprang to the front and stretched its mesentery, assuming the shape of a figure of 8 (Fig. 21).

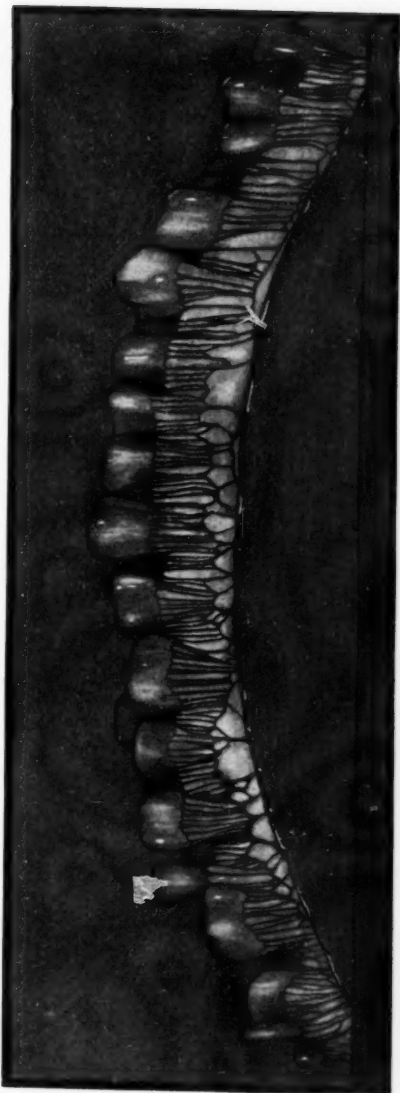


FIG. 19.—Showing a portion of the jejunum-ileum from which all the mesentery has been removed except the adjacent strip, about two inches in width, from the two ends of which the tube is suspended. This strip of mesentery includes nearly all, if not all, of the puffed border. The different segments of the intestine tend of themselves to hang alternately on the two sides of the mesentery.

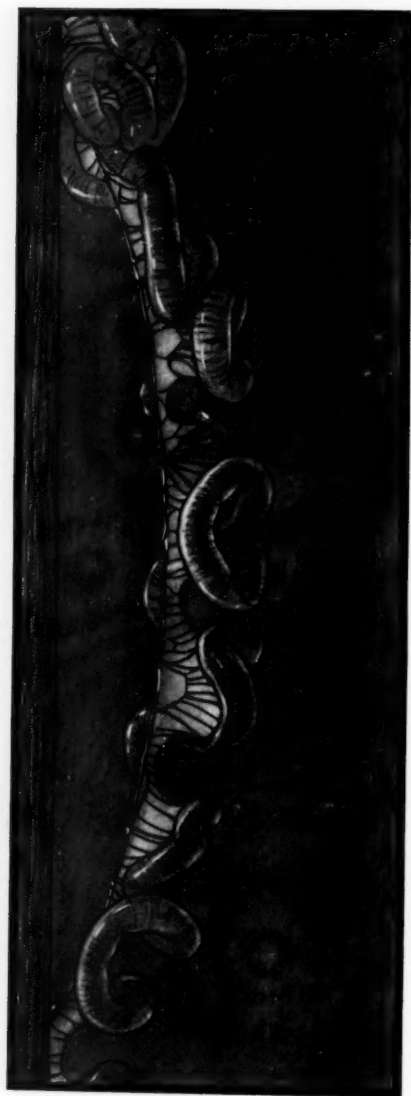


FIG. 20.—Showing the same specimen inflated. The alternation of the loops is still further emphasized. These loops spring laterally from below the cut line of the mesentery, and tend to encircle it. Another curve, reaching from side to side, and with its convexity downward, is evident along the whole length of the specimen.

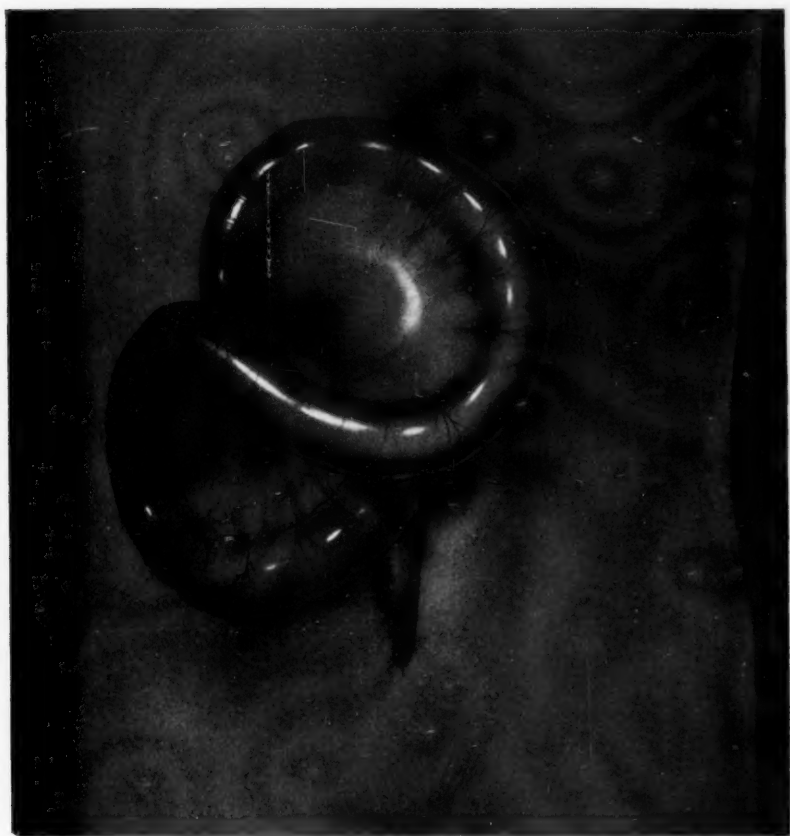


FIG. 21.—Showing the figure-of-8 shape assumed by a two-foot piece of intestine when it is inflated *in situ*.



FIG. 22.—Showing the alternating curves assumed by an intestine when it is inflated, when the mesentery along the base of its ruffled edge is held rigidly in a straight line.

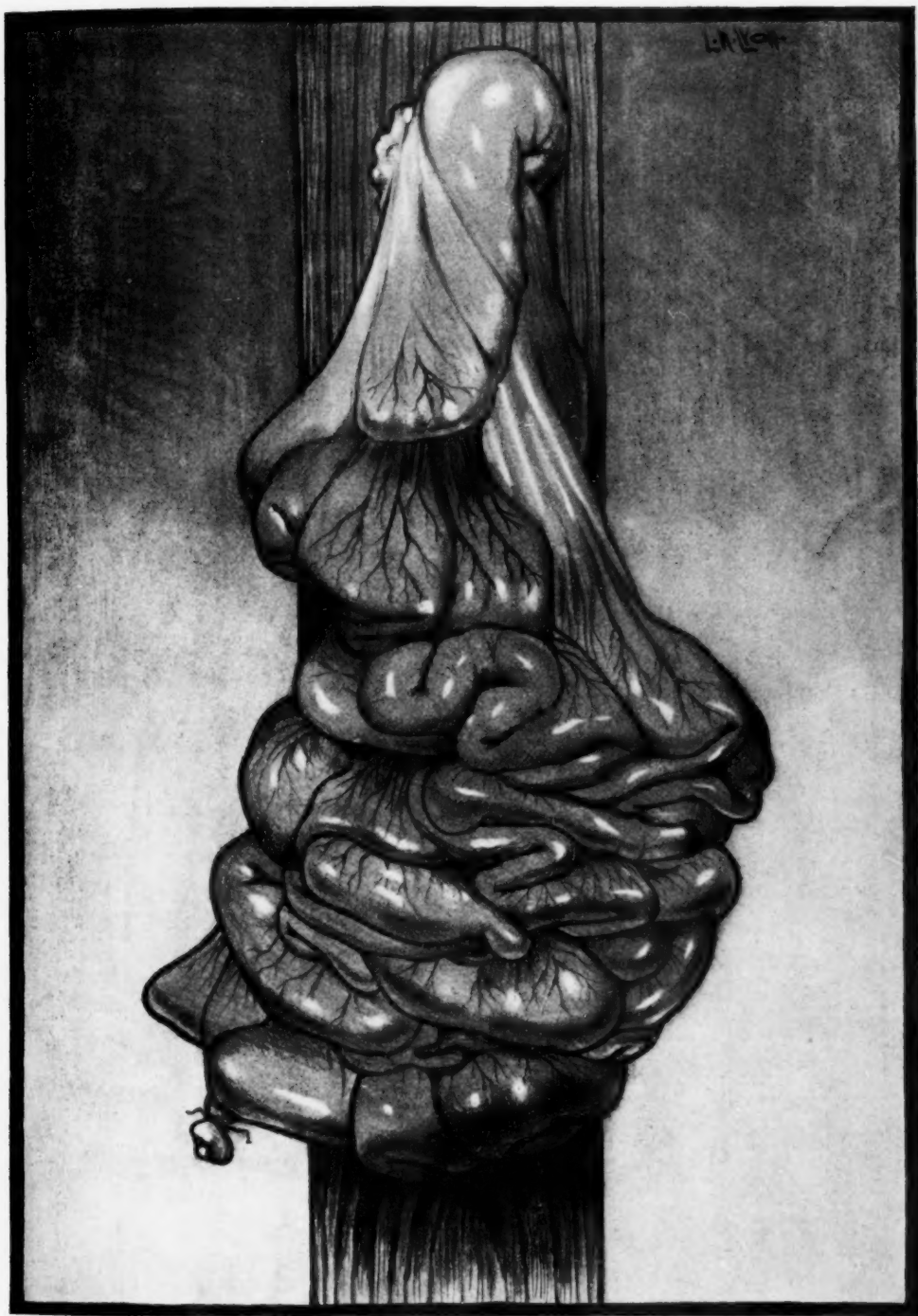


FIG. 23.—Showing a specimen of recently removed intestine and mesentery, suspended from the root of the latter, which has been nailed to a board. The whole is held in a position nearly vertical. The mass has somewhat the same relation to the mesenteric root that it would have in life if the subject was in the erect position. The alternation of the loops is evident, especially in the upper part of the specimen.

It was evident from these experiments that, while inflation of a short loop of bowel would cause such a loop to assume a single curve, inflation of a longer piece would result in figure-of-8 or sigmoid curves, and that inflation of a still longer piece would cause the bowel to assume a serpentine course, made up of a series of loops, alternating first to one side and then to the other.

In the next experiment a long piece of bowel, and a strip of its adjacent mesentery about 2 to 2½ inches in depth, were used. This mesenteric strip, which roughly represented the ruffled border of the mesentery, was nailed along its proximal edge in a straight line to a board. The ends of the gut were then tied up and the tube inflated. The result was what might have been expected, for, on inflation, a fairly regular series of alternating curves formed, the mesentery assuming a corresponding shape (Fig. 22).

It should, of course, be borne in mind that in the abdomen the base of the ruffled border is not straight, as represented in Fig. 22, but that it is more or less serpentine in its course. This, of course, makes the arrangement of the coils of intestine as they exist within the abdomen still more complicated than it would be if this base were straight.

With the idea of simulating even more closely than in the last experiment the conditions within the abdomen, a specimen comprising the small intestine and its entire mesentery was experimented upon. The mesenteric root of the specimen was nailed in a straight line to a board, and the board held in a position nearly vertical. On examining this specimen, especially the upper part of it, we see that the natural folds of the mesentery end in corresponding folds in the gut, the alternating arrangement of the latter being evident (Fig. 23).

We now inflate the bowel in this specimen, and such great irregularities appear in the distended coils that at first no definite arrangement is recognizable (Fig. 24). We see, however, that there are many loops of different shapes and sizes, whose planes differ considerably in reference to one another,

and on careful inspection we recognize here and there a sigmoid curve. From what we have learned in the preceding experiments, I think we are justified in considering that each loop represents a part of the alternating arrangement of loops already referred to, the compensating loop, if not on the surface and open to view, being hidden in the intestinal mass; and also that each sigmoid curve of the intestine represents the connecting link between two such loops. The curving of the intestine during inflation, combined with the crowding of the distended coils upon one another, was very marked in this experiment. When the intestine was fully dilated, the mass of coils reached so far around the sides and back of the board on which the specimen was mounted as to nearly encircle it.

Kinks in the intestine. Whenever my attention has been called to the existence of kinks in any part of the intestinal tube, I have noticed that these kinks are almost invariably *on the lateral aspect of the gut*, that they are seldom on the mesenteric border, and only in the rarest instances on the free border. There are several examples to be seen in Fig. 24. Kinks are simply exaggerated instances of sharp curves, and are caused, at least when the gut is distended, principally by the restraining effect of the mesentery, which obliges the intestine at these points to double sharply on itself. The pressure exerted by the other coils in the neighborhood probably assists to some extent in the formation of these kinks.

COURSE OF THE INTESTINE AS AFFECTED BY CONDITIONS WITHIN THE ABDOMEN.

When the intestines are within the abdominal cavity, the conditions are so different from those we have been considering that it is not surprising to find the regularity in the disposition of coils considerably interfered with. New factors, such as pressure from other viscera, or from one coil on another, or from unequal weight because of distention by gas or fluid intestinal contents, or from peristalsis, or from the changing position of the body, add very disturbing elements to the regu-



FIG. 24.—Showing the effect of inflation on the intestine seen in Fig. 23. The specimen is still held to the board by the root of the mesentery. The various loops of intestine, some of which appear in well-rounded curves or in kinks, while others take a sigmoid course, presumably form parts of the alternating arrangement of loops to which reference is made in the text.

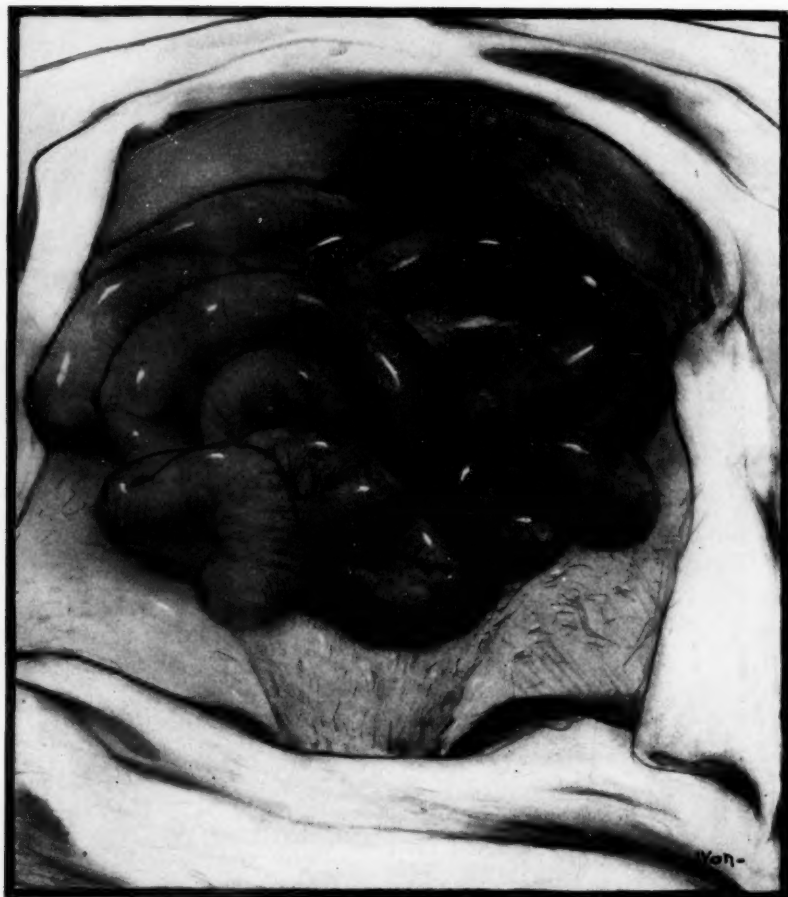


FIG. 25.—Exhibiting the wide open abdomen, in which the coils of small intestine, having been moderately distended with air, have sprung to the front. Large loops of different curves and a few kinks are seen. Presumably, the compensating loops are mostly buried in the mass of intestine. One sigmoid curve is evident in the left lower corner of the drawing. (Drawn from the subject.)

larity of the alternating curves. Some of the curves may be longer and some shorter than most of those which we have thus far been considering, and their planes may be greatly altered in reference to one another, one curve being in the front of the abdomen, and the next in the middle or back of it; but, by careful examination, evidence of some such alternating arrangement as we have spoken of can generally be made out, *if we look far enough*; for I hold it to be impossible, on account of the arrangement of the ruffled border of the mesentery, to which is attached an intestine longer than itself, that a segment of intestine can proceed for any appreciable distance on one side of the mesentery without crossing to the other side to form a compensating curve. In Fig. 25 the entire small intestine is shown inflated *in situ*. Most of the loops are large ones. There are a few kinks. The compensating loops are presumably beneath the other coils. One sigmoid curve appears.

CONCERNING DISTENTION OF THE INTESTINES; EXPERIMENTS IN THE INTRODUCTION AND REMOVAL OF AIR AND WATER.

I have often noticed that when in operations an enterostomy is done to relieve a gut distended with gas and liquid contents, usually little gas or other contents escapes at the time of operation, and that, therefore, the abdominal distention is not reduced to any great degree. I have therefore opened a number of gas-distended coils on the cadaver, to find that in every case the collapse of the gut which followed the escape of the gas was a purely local one, only a coil or two emptying its contents, while the rest of the intestine remained as much distended as before. It was obvious, therefore, that there was some obstruction to the escape of the gas from the other coils of intestine, and I came to the conclusion that the small intestine consisted presumably of various segments, not always opening freely into one another, which segments acted as separate reservoirs for gas or other contents, and that the

collapse by emptying of one of them did not necessarily mean the emptying of the others, at least, not their immediate emptying. These remarks refer, of course, to the dead intestine, or to the living one which is completely paralyzed.

In order to study this matter a little farther, I conducted a number of experiments by inflating the gut on cadavers. All these experiments were performed with the abdomen fully laid open. First, I inflated the whole tube by the use of a hand bulb, forcing air through a cannula into the intestine. The effect was what might have been expected, for the loop nearest the cannula would slowly become distended, and, as it did so, it would spring up from its bed, at the same time putting its mesentery on the stretch. At this point it was noticed that it was harder to inject air into the gut than had been the case at first; in other words, one seemed to be working against a slight obstacle. This obstacle would suddenly give way, and the inflation process would go on smoothly for a time until another obstacle was met, which in its turn would also give way; and so on, one chamber after another being opened up until the entire gut was fully inflated, when usually air could be forced from one end to the other. During all this, with each new reservoir opened up, the loop into which the air was entering would spring to the front and stretch its mesentery. When the whole tube was fully inflated, an incision into any coil would be followed by a gradual subsidence of apparently all the coils. This would take place up to a certain point, when the general collapse would be arrested, and the complete collapse of the coils nearest the opening follow, the other coils still remaining somewhat distended. Obviously, the pressure remaining within the distended coils was not sufficient to force out all the air which had been injected. Gentle pressure on the distended coils had the effect of forcing out more air, and massage was still more effective; but it was next to impossible to remove all the air without actually "stripping" the intestinal tube throughout its whole extent.

Some injections were tried with water and some with

water and air, but they demonstrated little beyond what one would expect; that is, that the water sank to the most dependent parts of coils, the air remaining in the uppermost parts. It was interesting, however, to note that when a distended loop on the front of the abdomen (the subject lying on his back at the time) was punctured, air escaped, but no water, and that on opening one of the most dependent loops water escaped, but usually little air. This water in the dependent loops evidently acted as a most efficient trap, like a plumber's trap, separating the different segments of the intestine; and, inasmuch as no single coil can continue along the anterior abdominal wall for any distance without taking a course near the back, it follows that wherever there is fluid enough in the intestines there must be traps which shut off the different compartments of the small intestine from one another. It is quite possible, in intestines filled, as in peritonitis, with gas and semi-liquid contents, that the gas is in the loops nearest the abdominal wall, the fluid being posterior in the dependent loops. If this is the condition of things, it is evident that opening the gut, or, in other words, doing an ordinary enterostomy, will not be followed by an immediate discharge of all the contents or a collapse of the bowel, but that it will be necessary to wait for a certain amount of peristalsis to drive the intestinal contents downward. In addition to the obstacles presented by these traps in the most dependent loops, there are, of course, other obstacles, for semisolid contents may act as such, or obstructive kinks may be present in the intestine. Apparently also the weight of the intestinal mass may press the sides of the gut so firmly together that even the pressure within the adjacent distended gut is not sufficient to open up the tube and allow the gas to pass on.

A few experiments were made with the idea of determining whether it was possible, by suction through a tube tied into the gut, to empty an appreciable length of the intestine. The results were very unsatisfactory, as the experiments showed that very little fluid or air could be withdrawn from the

intestine in this way. Equally unsatisfactory was the result of an attempt to irrigate from one end of the intestine to the other. This was tried only once, the abdominal contents being *in situ*, and the median wound in the abdominal wall being united over them. The greatest care was taken to inject the water slowly and gently. The result of the experiment was, as might have been expected, to show that such irrigation would be quite impossible on the living subject, for in the experiment the intestine ruptured and the fluid escaped into the peritoneum.*

THE PASSING OF INSTRUMENTS INTO AN ENTEROSTOMY OPENING.

While the passage of a tube into an enterostomy opening in the gut may allow the escape of a considerable quantity of intestinal contents, beyond that which has escaped from the hole itself before the tube was inserted, and while this quantity may be somewhat increased by gentle massage of the abdomen or by flushing, it is hardly possible, on account of the tortuous course of the tube, to pass any instrument, hard or soft, straight or curved, for any appreciable distance either upward or downward, without the probability of very soon engaging a sharp curve or kink in the gut. Before, however, the tip of an instrument reaches a kink, or even a sharp curve, it is very likely to engage the wall of the gut, usually its free border (Fig. 26). This I have repeatedly

* During these experiments, the attempt was made on two or three occasions, when the gut was fully inflated, to rupture it by what has been called "blunt violence." It was thought possible that distended intestines might rupture under a blow, just as an inflated paper bag ruptures under it, and that, if so, this fact might explain how the bowel may be ruptured, without apparent injury to the abdominal wall, by the application of blunt violence. Though the results of these experiments were entirely negative,—for in no case did a rupture take place,—yet the experiments were too few to justify any definite statement as to the possibility of a rupture occurring in this way. It is quite possible, also, that the cadaver is not suitable for experiments of this kind.



FIG. 26.—Showing how soon a straight instrument passed into the gut may engage its free border.

proved on the cadaver, with different kinds of tubes, both hard and soft, when the gut was collapsed as well as when it was inflated.

A number of experiments were made to determine what length of intestine could be "gathered up" on a tube when the instrument was passed through an abdominal wound of the ordinary length, and also through an opening into the gut such as is made in most enterostomies. The tube best suited for this purpose was found to be a glass one with a curved extremity, the opening being on the concavity of the curve. The circumference of the tube was about half again as large as an ordinary lead-pencil. The largest size Coudé catheter answered the purpose nearly as well. The results, however, were not encouraging, for, while it was found that such a tube could be made to penetrate much farther in either direction than any of the soft tubes, it could not take up much more than three or four feet of the intestine, for the reason that the intestine could not be pulled farther out of the abdomen without undue traction on the coils within. Before leaving this subject, however, it should be said that if the wound in the abdominal wall can be made long enough, and if the tube itself is also of sufficient length, the greater part of the gut may be gathered up on the tube.

CONCERNING THE DETERMINATION OF THE REAL DIRECTION OF THE BOWEL IN A LOOP OF INTESTINE.

In connection with the work on intestinal localization already referred to, another study was made, also on cadavers, for the purpose of determining through an abdominal wound which was the proximal end of an intestinal loop, and which the distal. The method by which this determination was made was by following down the mesentery on one side of the gut as far as the mesenteric root. On cadavers the tests resulted in a large proportion of successes; and on the living subject, where I have been able to apply it in a certain number of cases, I have made, as far as I know, no errors. In

case twists of the mesentery are felt or seen, one should be careful to rotate the loop in such a manner as to untwist these and cause the intestine to run in the same direction as the base of the mesentery, when the mesentery, now parallel with its line of attachment, can be followed down to its base by the finger, and, in case the coils in the neighborhood are strongly retracted, by the eye. Failures, indeed, are possible; as, *e.g.*, when the wound is so far away from the mesenteric root that the latter cannot be reached with the finger,* or where complicated twists or extensive pathological processes prevent a proper manipulation or view of the root of the mesentery. Since first writing on this subject, I have been impressed with the obvious advantage of examining the mesentery on both sides instead of only on one side, the findings on the one side being verified or disproved by those on the other. In fact, on several occasions, I have been able to grasp the mesenteric root of the cadaver between the thumb and fingers of one hand, thus enabling me to determine the direction of the bowel with certainty. It is quite possible that this method may be of use on the living subject when the wound is large enough, and when a knowledge of the real direction of the gut will be of sufficient value to justify the manipulation.† The method of procedure is as follows:

The loop of intestine is gently lifted from the abdominal cavity, and the assistant grasps its two extremities and holds

* Though this method for determining the direction of the tube in any loop presenting was, I at first thought, original with me, I later found, as I stated in my article, reference to the method in Woolsey's "Surgical Anatomy" (1902); and, after the publication of my paper, I learned that it had been also spoken of in Stimson's "Operative Surgery" (1895), and in a short article in the London Lancet (December 22, 1883), by Mr. Rand. This last is the earliest reference to the subject which I have been able to find.

† Since writing the above, I have been able in an operation on the living subject to correctly determine the direction of a loop of bowel by this method.

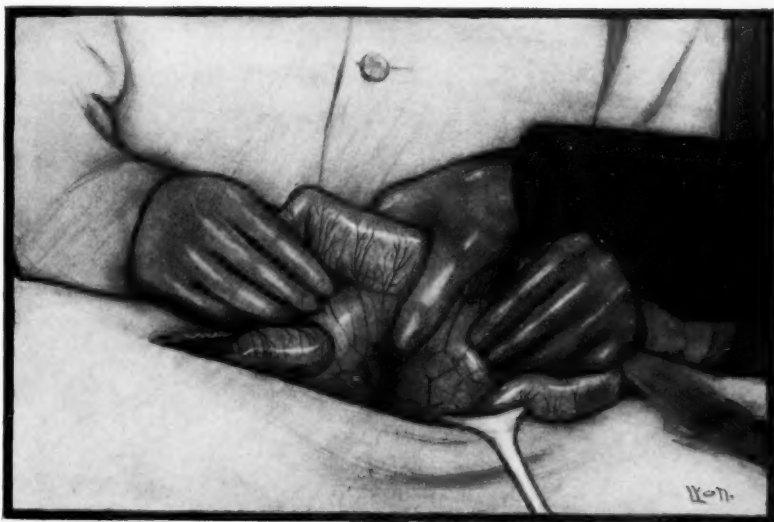


FIG. 27.—Showing the method of determining the real direction of the gut by passing the thumb down on one side of the mesentery, and the fore- and middle fingers down on the other, in the direction of the mesenteric root.

it suspended horizontally. The surgeon, putting his thumb on one side of the mesentery and his first two fingers on the other, insinuates them slowly down towards the root of the mesentery, the slack of the mesentery being taken up by his other hand and by the hands of his assistant (Fig. 27).

By this method, which requires a little practice, the examiner can instantly determine, and this usually before he reaches the mesenteric root, whether or not there is a twist in the mesentery. If there is a twist, it should be untwisted by rotating the loop of bowel, and the mesentery again examined. When there is no twist of the mesentery, and the loop lies parallel with the mesenteric root, the upper end is the proximal end of the loop and the lower end the distal.*

CONCLUSIONS.

Such is the nature of this paper that it does not admit of a satisfactory summary of all the points which have been spoken of in it. As, however, there are certain features which I particularly wish to emphasize, I put these in the form of conclusions. I have attempted to show:

1. That the relative shape of the mesentery and intestine *in situ* can be best understood by arranging the intestine in a series of alternating curves upon a wire, thus putting all parts of the intestine and mesentery gently on the stretch.
2. That the mesentery may be roughly divided into two portions: (1) a proximal or flat portion, which comprises

*A short time ago it occurred to me that, on the living subject, it might be possible to determine the direction of the bowel by the direction of the wave of impulse in the main branches of the superior mesenteric artery near the mesenteric root, it being, however, first made certain that there is no twist in the mesentery between the artery and the gut. This I have tried with success a few times on the cadaver, the impulse in the arteries being simulated by the rhythmical inflation of the vessels with air. I mention this method, however, only incidentally. Whether it can ever be made of practical value, I do not know. The only advantage it has over the methods already spoken of is that, in carrying out the test, it is not usually necessary to go as far as the mesenteric root, since the main arterial branches are often at some little distance from it.

about two-thirds or three-fourths of the mesentery; and (2) a distal or ruffled portion, the "ruffled border," which comprises the remaining one-third or one-fourth.

3. That the main sheets of the mesentery alternate from above downward, going first to the left, then to the right, and finally proceeding to the iliac regions and pelvis.*

4. That the fold of mesentery which descends into the pelvis can usually be palpated from a wound in the lower abdomen, and that it forms a valuable guide for the finger in the attempt to reach the left abdominal fossa. (I would make the suggestion that this fold be known as "the pelvic fold of the mesentery.")

5. That the part of the ileum which is about to enter the cæcum can usually be picked up from a right iliac wound by the forefinger, which, after passing into the pelvis, is curved upward around "the pelvic fold of the mesentery."

6. That while the intestine freed from its mesentery is straight, or nearly so, the mesentery when attached to it obliges it to follow a curved and tortuous course.

7. That, when the gut is attached to the mesentery, the free border of the gut is several feet longer than its mesenteric border, and that the free border may therefore properly be called "the long side," and the mesenteric border "the short side," of the intestine.

8. That the influence of the mesentery is such that the intestine is thrown into a series of alternating loops of varying shapes, sizes, and planes.

9. That kinks in the intestine are usually confined to the lateral aspect of the gut.

10. That a distended and paralyzed intestine, filled with gas or semiliquid contents, does not at once empty itself through an enterostomy wound. That the cause of this is obstruction, not only from sharp curves and kinks, but also from outside pressure on the tube, and still further because

* This roughly agrees with Mall's findings as to the arrangement of the different coils of intestine.

the fluid portions are in the dependent loops, where they act as traps to obstruct the passage of gases along the tube.

11. That, unless the intestine be "gathered up" on the tube, it is impossible to pass any instrument, hard or soft, straight or curved, into the gut without the probability of soon engaging the wall of the intestine, usually in its free border.

And, finally (12), that, when the size of the wound and its situation will permit, the surest method, at least on the cadaver, of determining which is the proximal and which the distal end of a loop of intestine is by palpation of the mesenteric root between the thumb and fingers of one hand.

A STUDY OF INFECTION OF THE KNEE-JOINT BASED UPON AN ANALYSIS OF 310 CASES.

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INFECTION in any wound presumed to be clean is a source of chagrin. The discomfort is somewhat modified by the possibilities in the individual case, but infection in certain regions is always looked upon with veritable horror. One of these regions is the knee-joint. Every surgeon has a clear conception of this calamity, and so pronounced is the impression universally, that there can be no doubt that many joints which might be opened to advantage are left untouched. We have investigated the subject for the purpose of determining, if possible, which cases are responsible for this general attitude, and to ascertain whether in the light of modern surgical technique this aversion is justified in all cases.

Fortunately and unfortunately, one's experience with infection of the knee is relatively small. Fortunately for evident reasons, unfortunately because much of value cannot be known as a matter of personal experience, but must be accepted as applying to scattered cases observed by different men.

During the last eighteen months the writer has endeavored to collect such data as would seem to bear upon this subject, and has examined the records of all cases available to him.

I am indebted to many surgeons in New York for allowing me to use their hospital cases in connection with my personal operations upon the knee, and, inasmuch as the cases were taken "as they came" in the records during the last ten years, it would seem reasonable to assume that the data obtained represent more nearly the actual state of affairs than would a similar collection of cases from literature.

Tuberculous, gonorrhœal knees and those occurring in

connection with osteomyelitis of the tibia and femur are not considered, only such as were operated for what is commonly termed "surgical infection." It may perhaps with justice be claimed that there is no reason for excluding the cases secondary to osteomyelitis, but the combination of osteomyelitis of the bones and knee-joint infection is such a vicious picture that the final results influence any conclusions all out of proportion. The condition is so disastrous as to be better treated by itself.

Comparatively few cases were investigated from a bacteriological stand-point,—evidently because the information derived would not have altered the course of treatment in the individual case. There is still much of value to be learned from more accurate knowledge of the bacteriology of knees which present all the cardinal signs and symptoms of infection.

Infection occurred in five groups of cases:

- a.* Clean knees operated.
- b.* Penetrating wounds of the knee-joint.
- c.* Primary in the knee without evident port of entrance.
- d.* In the course of evident infections elsewhere.
- e.* Following some trauma (non-penetrating).

Before entering upon a discussion of such cases as were operated because of the infection, let us examine the cases coming under any one of these five headings which did not seem to demand operation, and define our position with reference to the term infection. By infection we mean the entrance of bacteria into the joint, which event is followed by the cardinal signs and symptoms of such infection,—redness, pain, heat, loss of function, temperature, rise of pulse, etc. It is unnecessary to state that these cardinal signs and symptoms may be present to any degree. The presence or absence of pus is not considered. Pus is a vague term to be classified with such indefinite expressions as "fungus," for instance. There has grown up the idea that whenever this cloudy fluid which we call pus is found, the containing cavity should be opened as extensively as possible. This is a blind method of procedure, which cannot be made to apply universally, however appropriate in the vast majority of cases. Everybody knows

that certain pus cavities will heal after aspiration, and we prefer this method when conditions allow because of the danger of secondary infection. The relation between the character of the infected fluid in a knee-joint and the patient's power of resistance as indicated by the cardinal signs and symptoms of infection is our guide for operating. A knee-joint may contain creamy pus with very few signs and symptoms. This joint would better be aspirated and treated, as certain inguinal and tuberculous abscesses, rather than open freely and expose to all sorts of contamination. Not pus, but the character of the contained infected fluid is our guide for free openings.

It is common occurrence to obtain a negative bacteriological report from abscess cavities, yet nobody questions the infectious origin of the trouble. This applies also to the knee-joint. That the knee-joint exercises a certain amount of germicidal power as we should expect can be demonstrated in the following manner. When operating upon a knee with an excess of synovial fluid, first aspirate into a clean cover dish; on opening the joint, uncover this dish and one containing gelatin or agar. Cover them at the end of the operation and place in an incubator. Both will be found to contain colonies. The fluid in the joint is again aspirated on the day the cultures are investigated, examined immediately and placed in a cover dish. Both examinations will prove negative in cases we consider clean. There is no reason to suppose the air immediately over the field of operation was any cleaner than that over the two dishes. If more knees were examined in this way, we should be in a better position to state what the bacteriological condition of many knees were which show postoperative signs and symptoms not to be distinguished from those produced by infection.

Again, we have the knee presenting cardinal signs and symptoms of infection, yet on aspiration the joint fluid is sterile. These are supposed to be due to toxins secondary to some infection elsewhere in the body which may or may not be apparent. How many of these knees are really due to this

ascribed cause will only be known when we have more information regarding the milder cases of bacterial infection which recover without open operation.

Every surgeon has regarded with anxiety the signs and symptoms arising after an operation upon the knee and in cases of penetrating injury to the joint. The cardinal signs of inflammation are all there, but not sufficiently marked to demand reopening the joint. The symptoms gradually subside, the knee recovers. There can be absolutely no question that certain of these joints are mildly infected.

Another group, the last, which may present these cardinal signs are the non-penetrating traumatic knees. Almost every severe injury to the knee presents these signs to some degree; yet we do not worry; the joint is not open, and we know that infection otherwise than through a wound is rare. Still, this can happen, as we shall see later, and in the absence of bacterial proof we cannot claim that even some of these knees are not infected.

There is one point, however, which attracts attention. Non-penetrating injuries to the joint rarely show signs and symptoms for any length of time; whereas in penetrating wounds, whether operative or traumatic, the symptoms continue for several days up to weeks. It does not seem reasonable to assume that the penetrating nature of the wound should be made responsible for this difference in the clinical picture. We prefer to consider that many of the penetrating cases are infected.

A late examination in any one of these five classes does not enable us to state what was the primary cause of the function disability. The same condition may be secondary to trauma, bacterial infection, or irritation from toxins. Our only guide would be a bacteriological investigation at the time of the primary difficulty; and, although made in scattered cases, the number we have is not sufficient to warrant any more definite statement than the above.

Joints belonging to the rheumatic group have not been considered.

The fact that there are cases belonging to each of the above five groups which do become so bad as to demand operation, and the fact that bacteriological proof does exist in certain of these cases, is evidence sufficient that all of these joints do at times become severely infected. It is not reasonable to assume that when infection does occur it is always severe. Mild cases must also exist; the above mentioned unknown quantity, *i.e.*, the relation between power of resistance and character of infection, alone determining the nature of the clinical picture.

The situation is quite different when we consider the cases which have been operated because of infection. Here the data at hand, although not complete, are sufficiently accurate for clinical purposes to allow of deductions regarding the frequency of infection of the knee and the final outcome of such cases. Of 237 clean knees operated, 11 became infected and were subsequently reopened. This means that approximately one out of every 21 to 22 operations upon clean knees becomes sufficiently infected to demand opening and draining the joint, *i.e.*, 4.6 per cent. If we investigate to determine what the immediate outcome of such infection is we find that one case came to amputation, *i.e.*, 9 per cent. of the infected cases, and that the stay in the hospital was from one to six months, the average being three months and ten days. This does not mean that the patients were all well on discharge. Many had sinuses. It would not be of any value to say what percentage, because of the uncertainty of the data obtained on this point. Many were discharged with varying degrees of functional disability, from slight limitation of motion to complete ankylosis, with some subluxation in a few cases.

On examining these septic cases somewhat more closely, we find that in 8 of the 11 the primary reason for interfering was some recent trauma, and that in only 3 was the operative indication some other pathological condition. This means that of clean operative cases which become infected, about 73 per cent. are traumatic cases primarily and only 27 per cent. of pathological origin. The total number of traumatic cases

operated before the fifth day was 66, seven of which became infected, *i.e.*, about 11 per cent.

The total number of non-traumatic cases and traumatic cases operated after the fifth day was 141 with four infections, *i.e.*, one out of every 35, or about 2.9 per cent.

The total number of non-traumatic pathological cases (loose cartilage, foreign bodies, chronic synovitis, etc.) was 70, with three infections, *i.e.*, one out of 23, or about 4 per cent.

In 28 cases the time data could not be obtained.

The fracture of the patella group is largest and perhaps of greatest interest. Of 150 simple fractures of the patella operated, seven became infected and demanded subsequent operation, *i.e.*, one out of every 21 to 22, or about 4.66 per cent. The other groups are represented by so few cases comparatively, that no statistical representation of value could be brought forward. Of the septic patellæ, one was operated four hours after injury, four on the second day, one on the third day, and one after some months. In 128 of the 150 cases of operated fractures of the patella, the time elapsed between the injury and the operation could be determined. In 71 of these it was five days or more, in the remaining 57 it was under five days. Of the cases operated on after the fifth day one became sufficiently infected to demand operation; of the 57 operated on before the fifth day, six became infected. Provided the time elapsed between injury and operation in the 22 cases where the data are insufficient is in the same ratio as in the 128 cases where the time is given, the percentage of simple fractured patella operated after the fifth day which become infected, is about 1.2 per cent., whereas of the cases operated before the fifth day, 8.9 per cent. become sufficiently infected to demand reopening the joint. This would seem to indicate that in this region operating in bruised, lacerated tissue before active repair processes are well established is about eight times more liable to be followed by infection than when operating after a delay of five days, which corresponds in kind with experience in traumatic surgery elsewhere in the body.

The next group consists of the infections in penetrating traumatic wounds. The data obtained here are such as to make us always look upon an accident of this sort with anxiety.

Of 52 penetrating traumatic wounds, 30 became sufficiently infected to demand secondary operation. These were: lacerated wounds 19; punctured wounds, 8; 1 compound wound of joint with small piece of condyle broken off, infected; 3 gunshot wounds, with two infections. This means that three out of five, or about 60 per cent., of all penetrating wounds of the knee-joint become severely infected. The numbers in the individual groups are so small as to preclude deductions; but if the lacerated and punctured wounds be considered together, it is found that 20 out of 39 were infected, *i.e.*, about 50 per cent.; and if the compound fractures of the patella be examined separately, it will be seen that seven out of nine became infected, *i.e.*, about 78 per cent.

The immediate outcome of these penetrating infected wounds is as follows: Of 30 cases, four died with or without previous amputation, two legs were amputated, and two knees resected. Of the remaining 22, two were removed from the hospital against advice, while 20 were discharged sooner or later with a varying amount of disability. Four of these had complete ankylosis on leaving the hospital. The stay in the hospital varied from five days to six months and two weeks, the average being two months and three weeks. This is somewhat less than the average for operations upon clean knees which become infected, due possibly to the fact that three of the fatal cases were in the ward less than one week. All of which means that one out of every thirteen penetrating traumatic injuries to the knee-joint died, *i.e.*, a death-rate of 7 to 8 per cent., and one of every seven to eight of the infected cases dies, *i.e.*, a death-rate of 13.3 per cent. One out of every 26 cases of penetrating traumatic wound to this joint comes to amputation, *i.e.*, 3 to 4 per cent., and 1 in 15 of the infected cases comes to amputation, *i.e.*, 6 to 7 per cent.

We next consider the cases which become infected suffi-

ciently to demand operation after some known injury to the joint. These cases were not operated for the trauma. Of these we have been able to collect six. The injuries were: One horse-kick, two blows, two falls, one run over and knee twisted. In none of these was the joint opened. The signs of infection became sufficient to demand operation on the fourth, fifth, seventh, tenth, and twenty-first day. One case died, one came to amputation. The other four were discharged with a varying amount of disability. These cases stayed in the house, with the exception of one case leaving against advice, from five days to five months and two weeks, the average being two months. The infection must have occurred much in the same way as in acute osteomyelitis after injury.

The next group of cases includes those infected knees where no history of trauma or evident focus of infection elsewhere could be found. There are eight cases. One died after amputation, the rest were discharged with varying degrees of functional disability. It is a curious fact that each and every history in this group, taken by different men at different times, points out that the onset was sudden, sometimes with chill. The time elapse between onset and operation varied from ten days to six weeks, the average being three weeks and five days. There were three males and five females. A bacteriological examination made in six cases showed "cocci" and denies gonococci. We know that other bacteria besides the ordinary cocci can infect joints, especially the pneumococcus; but, inasmuch as all of these patients were between eighteen and forty years,—the gonorrhœal age, as it were,—five being twenty-five or under; and considering the fact that five were females, not apt to be questioned or examined too closely, a quite unusual preponderance compared with the sex ratio in the other groups, it would seem to me that some of these bacteria might possibly have been gonococci.

The last small group of cases represents those infected knees occurring in the course of some evident infection elsewhere or immediately after such infection. The conditions in connection with which these joints appeared are as follows:

Multiple boils, one case; severe bronchitis, one case; excision of gumma of thigh, one case; cholecystitis, one case; septic uterus, one case; inguinal adenitis following septic focus on foot, two cases; seven cases in all. One case died, the rest discharged. The knee symptoms appeared from the second to the twenty-third day after the onset of the first septic process. Unfortunately, there is no bacterial proof that the two processes were caused by the same bacterium. In three cases "cocci" were found in the joint, but in the remaining four there is nothing to prove that the conditions might not belong to the group of cases supposed to be caused by the irritation of toxins or by an independent infection.

If all of these septic cases be considered together, we have sixty-two infections sufficient to demand operation. Of these seven died, *i.e.*, about one in nine, or about 11 per cent.; four came to amputation, *i.e.*, one in fifteen, or about 6.6 per cent.; two were resected, *i.e.*, 3.3 per cent., and 49 recovered, *i.e.*, about 76 per cent., with functional disability varying from slight limitation of motion to complete ankylosis. The average stay in the hospital was between two and three months (ten and one-half weeks).

In searching for data which might aid us to treat these severe infections more successfully, we find little that is to guide us. There are numerous knees evidently infected which are never opened or reopened; still, they recover with varying subsequent disability. As already mentioned, the bacteriological information which would enable us to interpret many of the conditions is absent except in individual cases. At the present time, a knee-joint is reopened only when the combination of signs and symptoms is such as render it beyond question that we have to deal with an extreme condition. The final outcome is well indicated by the above remarks. Had we more definite information regarding the early stages of these severe conditions, and were we able to distinguish from joints, which, although presenting similar signs and symptoms, were not apt to run so vicious a course, we would be in a posi-

tion to attack the severe infections earlier and perhaps improve the outlook.

If a joint is to be opened and drained at all, the first operation should be radical. If open operation is necessary, it is necessary to be extreme. This is plainly shown by the fact that many of the knees operated for infection were reoperated at some later date to get increased drainage. This should have been done in the first place, not after conditions are worse and the chance of favorable termination so much less. Of the seven fatal cases four were opened and reopened. Not that this is proof that an early more radical procedure would have changed the final outcome. The ever unknown relation between power of resistance and strength of infection prohibits such a deduction. But considering the possibilities, the extreme should be done at first to get the maximum amount of good at once.

Most cases are irrigated with some antiseptic. There is a happy medium between the amount of good done by an antiseptic and the amount of harm done to tissues. There is no question that carbolic and bichloride of mercury do destroy cells and diminish the function of others. Still, we do not feel that clinical evidence allows us to join the ranks of those who would discard these agents entirely for a purely mechanical cleansing agent, such as salt solution. We do not feel that the damage done to cells and their function is greater than the good derived from attenuating the virulence of the offending bacterium by the occasional use of some antiseptic. If we could, we would sterilize the entire cavity, cauterize it, and dress it aseptically as it were, to leave the process of healing to take care of the sterile dead tissue. For evident reasons this is not practical, and we believe that it is best to do the next thing, sterilize little by little with some antiseptic fluid and leave the body to replace the damaged cells. There are cases which go from bad to worse in spite of any cleansing agent or antiseptic, but we cannot believe that the process extended because of the use of an antiseptic which diminishes at least the virulence of the parasite.

In less acute cases the leg should have continual traction to prevent subluxation.

Every infected knee is a huge abscess cavity with many pockets hard to drain. Any anterior incision can but poorly serve the purpose at best. We drain the top of the abscess but not the parts behind, neither do we drain any bursa which may happen to communicate with the joint. The bursa near the semimembranosus is the most often troublesome. It is our opinion that it is much better to keep these unfortunate people on their faces as much as possible, after making liberal drainage openings. If there are infected bursæ, these should always be opened. Various incisions have been used in the above cases, from complete transverse division to multiple openings front and back. Mildly infected joints, with moderate signs of infection where one is still in doubt as to the advisability of free open incision, should be treated as a synovitis by repeated aspirations. Certain joints will recover under this form of treatment even when the fluid withdrawn is very cloudy. It is the character of the fluid, not its macroscopic appearance, which is of importance. Should, however, the clinical signs indicate that the infection was progressing, then the utmost in the way of open operation should be done at once.

These figures represent the average conditions.

To summarize, let us say :

Non-penetrating injuries, penetrating injuries traumatic or operative and knees independent of any injury in the course of some other infectious process or not, may present signs and symptoms not to be distinguished in the absence of bacteriological examination from the cardinal signs and symptoms of infection.

Certain of these cases are undoubtedly infected, but the data at our command do not allow us to distinguish these from such as may be due to trauma and those possibly due to toxins secondary to infection elsewhere.

The knee-joint has certain germicidal powers.

One out of every 22 operations upon clean knees becomes sufficiently infected to demand operation (4.6 per cent.).

One out of every 9 operations for recent (5 days) traumatic non-penetrating injury becomes sufficiently infected to demand operation (11 per cent.).

One out of every 35 operations for pathological conditions other than traumatic injuries more than five days old becomes sufficiently infected to demand operation and draining the joint (2.9 per cent.).

One out of every 22 operations for simple fracture of the patella becomes sufficiently infected to demand operation (4.6 per cent.).

One out of every 71 operations for fracture of the patella done after the fifth day becomes sufficiently infected to demand operation (1.2 per cent.).

One out of every 9 to 10 operations for fracture of the patella done before the fifth day becomes sufficiently infected to demand operation (10.5 per cent.).

Three out of every five cases of penetrating injury to the knee-joint become sufficiently infected to demand operation (60 per cent.).

Of compound fractures of the patella, seven out of nine become sufficiently infected to demand operation (78 per cent.).

Certain knees subjected to non-penetrating injury and not operated become sufficiently infected to demand operation (10 per cent. of the operated septic cases).

Certain knees become sufficiently infected to demand operation where no history of trauma exists or other evident septic focus in the body (13 per cent. of the operated septic cases).

Certain knees become sufficiently infected to demand opening and draining the joint in the course of some evident focus of infection elsewhere in the body (11 per cent. of the operated septic cases).

One out of every nine infected knees which have been opened and drained dies (11 per cent.; some after previous amputation).

One out of every fifteen infected knees which have been

opened and drained comes to amputation before recovery (6.6 per cent.).

One out of every thirty-one infected knees which have been opened and drained is resected (3.3 per cent.).

Most knee-joints which have been infected, opened, drained, and recovered show varying degrees of functional disability, from slight limitation of motion to complete ankylosis with or without subluxation.

The average stay in the hospital of an operated infected knee-joint is between two and three months.

When it is once determined to open and drain a knee-joint, the operation should be as radical as possible at the start.

The position of the leg should be that giving the best mechanical drainage, *i.e.*, the patient should be face down.

The risk of infection is greatest in penetrating wounds of the knee (60 per cent.).

The risk of infection is least in operations upon clean knees and where there has been no recent trauma (3 to 4 per cent.).

FIBROLIPOMA OF STOMACH.

REMOVAL BY RESECTION OF STOMACH; CONVALESCENCE
COMPLICATED BY TETANY.

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OF NEW YORK,

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SURGEONS are very rarely confronted with benign tumors of the stomach which are of non-inflammatory origin. They do not come to operation because in the majority of cases they are small and give rise to no symptoms. The benign tumors that are met with in the stomach are fibromata, fibrolipomata, lymphadenomata, and myomata. The last of these is probably the most frequent variety. Steiner,¹ who collected 51 cases of myomata of the gastro-intestinal tract, found 21 of the stomach. They arise from the muscularis, and grow either into the lumen of the stomach or towards the abdominal cavity. These tumors may attain a considerable size, and then give rise to symptoms merely because of their bulk. They may become inflamed or ulcerate, and thus create discomfort or even pain. Usually, they occur either at the larger or lesser curvature, and more rarely at the pyloric end. The diagnosis of benign neoplasm of the stomach is a difficult one. If they are palpable, and if they are known to have increased but slowly without interference with either the function of the stomach or the general health of the patient, the diagnosis can be made. Fibromata and fibrolipomata are usually small and produce no symptoms unless they become inflamed. However, I have been unable to find any cases recorded in literature in which an inflammation of such tumors has given rise to sufficient symptoms that warranted operation. I, therefore, may be permitted to report the following case that came under observation in the German Hospital. This case represents another interesting feature, namely, the development of tetany seventeen days after operation.

Mary S., thirty-seven years of age, was admitted to the hospital on February 23, 1904. Since January 17, 1904, she has suffered from attacks of pain in the abdomen, which occurred only during the day. The pain was of a dull aching character and varied considerably as to its site. Two weeks ago her physician found a small epigastric hernia and ordered an abdominal binder. This gave her no relief, the pains became more severe and localized in the epigastrium. Three days ago there was an acute attack of pain in the left umbilical region. It grew steadily worse, being sufficiently severe as to prevent her from sleeping. She has no nausea, and never vomited and has no cough.

Status Præsens.—Fairly well nourished, anæmic looking girl with club-shaped fingers. Over the apex of the right lung there is some dulness, with a little exaggerated and high-pitched expiration, but the lungs are otherwise normal. The heart is normal. When patient coughs, a small soft mass protrudes in the linea alba, about one-fourth of an inch above umbilicus. It is of the size of a cherry and easily reducible, the hernial opening admitting the tip of a finger. In the left hypochondrium just below the ninth rib there is a point of considerable tenderness; the left rectus abdominis muscle is very rigid, but no definite mass is palpable. The right kidney is movable and can easily be felt. The left kidney cannot be palpated. On February 25, a splashing sound can be elicited just above and to the left of the umbilicus. Over this area tenderness persists. Lavage of the fasting stomach and after administration of Ewald's test-meal reveals normal conditions. But if the stomach is distended with water the pain becomes more severe, and lets up somewhat when the water is withdrawn.

As the pains did not subside by rest in bed and careful dieting, it was decided to operate the epigastric hernia, on the assumption that it was probably the main cause of her suffering, and at the same time to carefully explore the stomach.

Through the kindness of Dr. O. Kiliani, the case was referred to me for operation.

I operated on the patient on the 29th of February. A 5-centimetre incision was made in the linea alba over the hernia. On opening the sac, it was found to contain a small portion of adherent omentum. The adhesions were severed and the omentum replaced. On opening the abdomen, the stomach was found to be

freely movable. The greater curvature, fundus, and pylorus were normal. On the anterior wall of the stomach and encroaching on the lesser curvature, there was found a hard red mass, the size of a large walnut, projecting somewhat from the stomach wall. The serous covering was of a dull red color and showed a number of dilated blood-vessels running towards the mass. The lesser omentum was thickened by inflammatory processes and closely adherent to the mass. On palpation the tumor seemed to involve the whole thickness of the stomach wall. The picture presented the appearance of an ulcer at the lesser curvature about to perforate. I therefore decided to excise the inflamed area, and resected a V-shaped piece of the anterior and posterior stomach wall, including the tumor. The cut edges were then sutured in the usual way. Examination showed that the mass originated from the muscular coat, the mucous membrane being entirely normal. The microscopical examination made by Dr. Weil showed the tumor to be a fibrolipoma with inflammatory changes and hæmorrhages in its substance. For the first ten days the patient was nourished by means of nutrient enemata and by small quantities of fluid per mouth, which were gradually increased until the fourteenth day, when she took solids the first time.

On the 17th of March, seventeen days after operation, she was suddenly seized with a severe paroxysm of pain during the night, located in the upper part of the abdomen and left hypochondrium. At 3.30 in the morning she had a typical attack of tetany. The spasms were limited to the upper extremities. The wrist-joint became gradually flexed to an angle of over 90° , more marked on the right side. There was a moderate flexion at the metacarpophalangeal joints, whereas the phalanges were extended. The thumb was adducted and flexed into the palm of the hand. The elbow-joint was flexed to about 45° . There was a visible intermittent contraction of all muscles of forearm, arm, and the pectoral muscles, without, however, producing any motion in the joints. After fifteen minutes' duration there could be noticed a gradual relaxation of the muscles on the left side; but the fibrillary twitchings still continued. Tapping of cheek just under malar bone and in front of lobule of ear over the facial nerve produced contractions of orbicularis oris and drawing up of the angle of the mouth on the same side (Chvostek's symptom). There was a slight relaxation of the right elbow after nineteen

minutes. Tetanic condition of right hand remained the same. After twenty-two minutes there was an almost complete relaxation on both sides. The fibrillary twitchings, however, in the affected muscles were still present. After subsidence of the entire attack, we could easily produce a new tetanic condition of one arm by pressure upon vessels and nerves (Trousseau's phenomenon). Compression for one minute produced at first flexion at wrist, then at metacarpophalangeal joints and phalanges, and within two minutes a marked contraction at the elbow was brought about, being accompanied by considerable pain. This tetanic condition, produced by pressure of the brachial vessels and nerves, was even more pronounced than the spontaneous tetanic spasms. There was a marked adduction of the phalanges, the ring and little fingers being overlapped dorsally by the middle and index fingers. The muscles of the lower extremities remained unaffected. The electrical irritability of all the nerves of the upper extremity was greatly exaggerated, weak currents producing tetanic contractions.

In the left hypochondrium, just below the ribs, a slight bulging could be noticed. This spot was somewhat tender to palpation, and succussion could be heard over it. A few friction sounds were also heard.

During the course of the day the patient had four more attacks: at 8.45 A.M., 10.15 A.M., 2.15 P.M., and 10.45 P.M. They all lasted about twenty minutes.

On March 18, Chvostek's and Trousseau's phenomena were still elicitable.

March 19. Patient had no more tetanic attacks, but Chvostek's sign was still present. Trousseau's sign, however, could not be produced after four minutes. The patient complained of some tenderness about the scar and also in the left epigastrium.

March 23. The patient felt well. Chvostek's and Trousseau's phenomena have disappeared. She complained of a dull and heavy feeling in left arm and forearm.

During the few days when the patient had her tetanic attacks there was a slight rise of temperature ($100-101^{\circ}$ F.). The urine was somewhat decreased in quantity, but that was probably due to the restricted amount of fluids taken. It was otherwise perfectly normal. The percentage of chlorides fluctuated between 0.73 per cent. (4.8 in twenty-four hours) to 1.5 per cent.

The general condition of the patient was always good. The pulse was full, regular, and of good quality; the appetite was good, and *she never vomited*, nor did she have regurgitation of sour fluid or gas from the stomach.

Tetany (the name was introduced by Lucien Corvisart in 1852)² in gastro-intestinal derangements is not very frequent. According to Riegel (*Erkrankungen des Mageus Teil I*), there are about forty such cases reported in literature. Kussmaul was the first one to call attention to this complication in cases of motor insufficiency and gastric dilatation, caused by gastric ulcer and carcinoma of the pylorus associated with hypersecretion. Bouveret and Devic³ thought that this hypersecretion was the main cause, and that gastric tetany occurred exclusively in this condition. But Fleiner, according to Kaufmann,⁴ reported some cases where hypersecretion was absent. Four different theories were brought forward to explain these spasms.

1. *Kussmaul's Theory.* He thought they were due to the loss of water from the tissues in the body, analogous to similar spasms occurring with Asiatic cholera and cholera nostras.

2. *Reflex Theory.* There are some cases recorded in which spasms occurred after the use of the stomach-pump. Müller⁵ observed a case where he could produce an attack by slightly tapping the region of the stomach.

3. *Intoxication Theory.* This theory was advanced by Albu.⁶ According to him, the resorption of toxins from the gastro-intestinal tract is to be held responsible.

4. *The Loss of Chlorides in the Tissues.* This theory was advanced by Korszynski and Jaworski in 1891. To this theory very little attention has been paid by the various authors who have written on the subject. Sufficient importance to this theory is given only by J. Kaufmann in his admirable article on *Gastrosuccorrhœa*.⁷

In looking over the reported cases of tetany following gastric disturbances, the largest number was associated with

a large amount of hypersecretion of a gastric fluid, very rich in hydrochloric acid. At the same time the chlorides in the urine were diminished or entirely wanting. As the amount of food taken by these patients is very small, one can easily see that the loss of chlorides for the body can under such circumstances be large enough to seriously disturb the nutritive equilibrium of the tissues.

As we study the cases and try to explain them by the theories promulgated, we find that the same theory is not applicable to all cases. The idea that an intoxication is the main cause of these tetanic attacks has been accepted by a good many investigators. The rise of temperature that almost invariably accompanies the attack speaks in favor of this. In some regions, epidemics of tetany arise, as for instance in Vienna during the months of March and April.⁸ Another strong point in favor of the intoxication theory is the possibility of saving a patient by gastro-enterostomy, thereby allowing the stagnated noxious masses in the stomach to be evacuated into the bowels and eliminated from the body.

Whatever the true cause of tetany in consequence of gastric disturbances may be, there is one striking feature about this disease, and that is its rarity. When we consider the large number of cases of motor insufficiency and hypersecretion of the stomach, from whatever cause, are yearly treated in private and hospital practice, the small number of tetany cases is surprising. The possibilities of exsiccation of the tissues, of reflex disturbances, intoxication, and loss of chlorides are given in almost every such case. All these causes, however, are not sufficient; there must be in addition a special vulnerability of the nervous system. If we analyze our case, there are some features of interest connected with it.

1. The attack came on after an operation upon the stomach.
2. The patient never suffered from any condition which is known to lead to tetany.
3. The attacks were light. The patient recovered entirely. Tetany in the course of severe gastric diseases usually

terminates fatally. So far only a few cases have been saved by gastro-enterostomy. The mortality, according to Riegel, is as high as 70 per cent. The cause in our case was most probably also an intoxication. When the attacks began, the patient had some bulging in the epigastrium, caused undoubtedly by a distended stomach. One could hear the splashing of the fluid. The cause of retention in our case was probably a motor insufficiency of the muscular wall of the stomach caused by the severe trauma of the operation. This insufficiency was doubtless only a temporary one, for the patient never vomited. In consequence of the irritation that the retained fluid exerted upon the muscular and nervous apparatus of the stomach, the muscular wall contracted and emptied its noxious contents through the patent pylorus into the intestine. As soon as the poison was eliminated, the intoxication came to an end and the patient recovered entirely. The amount of toxins must have been very small, but, as our patient was of a decided neurotic taint, it sufficed to produce enough irritation upon her easily vulnerable nervous system to lead to an attack of tetany.

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- ⁴ F. Kaufmann. Remarks on Gastrosuccorrhœa, etc., American Journal of the Medical Sciences, April, 1904.
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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, April 26, 1905.

The President, HOWARD LILIENTHAL, M.D., in the Chair.

VOLVULUS.

DR. F. TILDEN BROWN presented a man of forty years, who when he was eight months old had an attack of what was probably anterior poliomyelitis, with complications affecting the right foot and leg, which at the age of twenty necessitated an operation on that extremity. He stated that previous to that operation his bowels had always been regular, but since then he had been troubled very much with constipation.

About a year ago, he began to have occasional attacks of abdominal disturbance, with flatus. He had such an attack two months ago, and for eight days he had no faecal movement, although flatus was expelled. The bowels finally acted after various cathartics had been used. Since then his bowels had moved about once a week until ten days ago, when he had his last dejection previous to his admission to the hospital. Flatus had been passed three days ago. During the past year he had lost considerable weight.

Upon admission to the hospital, the physical examination was negative, with the exception of the fact that the abdomen was hugely distended. There was no nausea. The temperature was 100° F.; pulse and respiration normal. Leucocyte count normal. There was a trace of albumen in the urine. No mass nor signs of fluid in the abdomen could be made out. There was no abdominal pain nor tenderness.

Operation.—Through a median incision, the enormously distended colon was exposed. It was fully nine or ten inches in diameter, and occupied nearly the whole of the abdominal cavity. In the pelvic region, the distended gut seemed to be constricted by a tense, cordlike band, which extended from the right to the left of the sacrum. The largest sized trocar and cannula was inserted into the distended gut for the purpose of withdrawing the collection of fæces, but this method proving too slow, an incision was made into the bowel, and two bucketfuls of fæces evacuated. The incision in the bowel was then closed by a series of sutures, and after untwisting the coiled intestine, the supposed constriction referred to above was found to have disappeared.

The subsequent history of the patient was uneventful. He had his first voluntary movement on the sixth day, and from that time on his condition steadily improved.

DR. H. LILIENTHAL said that in a case which he showed before the Society some years ago, in which he had pursued practically the same method as that described by Dr. Brown, namely, evacuated the gut, which was distended to about the size of an adult thigh, he sutured the intestine to the wound, and in that instance there was no recurrence. The question of the after-treatment of these cases was in a somewhat unsettled state. Some were in favor of taking steps to prevent a recurrence of the volvulus, while others claimed that a recurrence might occur in spite of anything that could be done to prevent it.

DR. BROWN said he had taken no steps to prevent a recurrence in the case he had shown. Thus far there were no signs of such a recurrence, but the belly was large and flaccid, and a recurrence was of course possible.

DR. JOHN F. ERDMANN said that six years ago he had a case in which he fastened the gut to the side of the abdominal wall, and there was no trouble in the future. Recently, he saw another case in which the sigmoid was enormously dilated, twenty-two inches in circumference, and three feet and nine and one-half inches long. In that case he also attached the emptied gut to the abdominal wall. Three weeks ago the patient had a similar attack, which was relieved by position and enema. The cause of the last obstruction was unknown.

INTUSSUSCEPTION.

DR. THEODORE DUNHAM presented an infant of four months, who was admitted to the Babies' Wards of the Post-Graduate Hospital on the 29th of January, 1905. The child's previous history was good, with the exception of an attack of bronchopneumonia last December. It had always been breast-fed, helped out by the bottle, and had been inclined to be constipated ever since birth.

The immediate history was that, thirty-five hours before admission, the child had suddenly become sick, crying out as though in pain. This was followed by a painful movement, containing mucus and bright red blood. Five similar stools had occurred up to the time of the child's admission, and one afterwards, which was particularly bloody. The child had been feverish; there was no history of vomiting; no convulsions; the urine was negative. The stools during the previous twenty-six hours had contained no faecal matter, simply mucus and blood.

On admission, a mass was felt in the upper left quadrant of the abdomen, about three inches long and an inch and a half wide. It was evidently an intussusception, and some effort was made to reduce it by means of enema, but this method was unsuccessful and was quickly abandoned.

Operation.—An incision was made in the median line from the symphysis to just above the umbilicus. After protecting the intestines with hot compresses, the seat of the trouble was located in the caput coli, some eight or ten inches of ileum being invaginated into the cæcum. The intussusception was reduced in about fifteen minutes by gentle manipulation, gradually milking out the invaginated portion. The gut was very tense and congested, and in the course of the reduction the peritoneal covering was repeatedly torn. No sutures were applied to the intestines.

During the operation and on the night following it, the child was in a very precarious condition, requiring free and repeated stimulation with camphor, whiskey, and strychnine. During the evening, it several times vomited a dark, greenish fluid. The temperature became normal on the third day, and remained so. Further recovery was uneventful. The child's constipation has gradually improved. For several weeks past an occasional teaspoonful of sweet oil is the only laxative needed. The child is in fine health.

DR. GEORGE E. BREWER said that in the reduction of three cases of intussusception that had come under his observation, very little had been accomplished by traction on the invaginated gut. Reduction was accomplished by the method described by Dr. Dunham, *i.e.*, gently milking and squeezing out the confined intestine.

DR. DUNHAM said he had a case where the tumor was on the left side of the abdomen, and after several high enemas it apparently disappeared entirely. No faecal matter was elicited by the enemas, however, and upon opening the abdomen he found that the intussusception tumor had concealed itself under the liver.

DR. LILIENTHAL called attention to the danger of giving young children strychnine after surgical operations, especially in acute cases. At times it gave rise to twitching and convulsions, and might even determine the fatal ending instead of acting as a true stimulant.

DR. ARTHUR L. FISK mentioned a case reported by Dr. Erdmann where the child suddenly died twenty-four or forty-eight hours after the intussusception had been perfectly reduced. The speaker said that he had had a similar experience, where the autopsy had showed no recurrence of the invagination or any cause of death. Death, in these cases, was probably the result of shock, and possibly in the case presented by Dr. Dunham it was the strychnine that had carried the child to recovery. The early nursing of the infant was also of great assistance. Warmth and warm, easily digested and stimulating nourishment are of great importance in preventing such unfortunate an outcome.

RETENTION METHOD AFTER HARELIP OPERATIONS.

DR. THEODORE DUNHAM presented two children to illustrate the use of a new retention method after harelip operations. In the application of this method, the materials required are two narrow strips of chiffon cloth, a strand of silkworm gut, and flexible collodion. Fig. 1 shows the device being applied. One end of a strip of the chiffon cloth is pasted to the cheek with collodion, beginning with the end of the strip out on the cheek and pasting it as far inward as the angle of the mouth, as shown at *A*. The silkworm gut, *B*, is then laid over the parted chiffon at the point

where the pasting was stopped, the free part of the strip, *C*, is folded back and pasted down upon *A*. The appearance then is

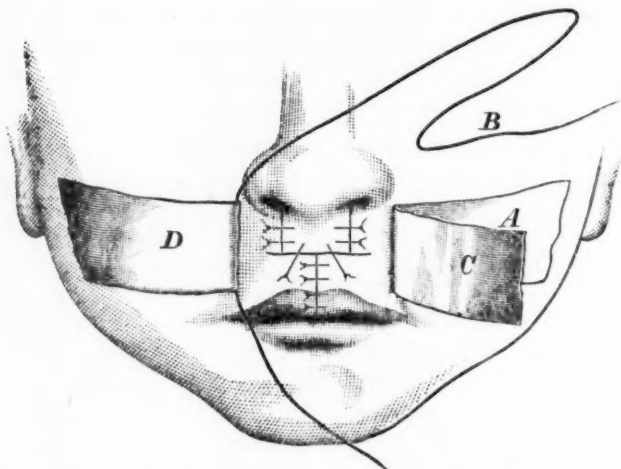


FIG. 1.—Retention straps for harelip; first step of application.

as represented at *D*. The strand of silkworm gut is thus secured on each side. The silkworm gut is so smooth that it slides easily

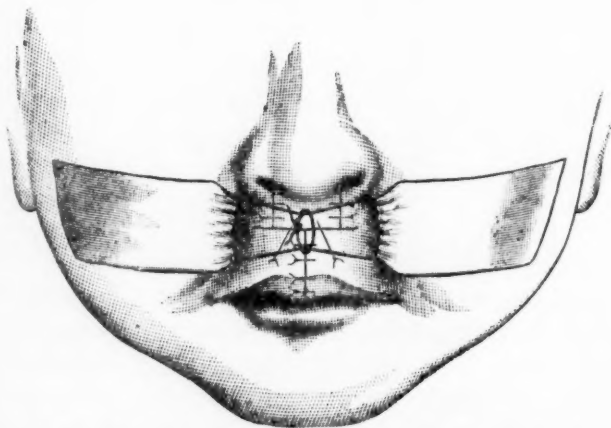


FIG. 2.—Retention straps for harelip; the application completed.

through the bight of the chiffon cloth. When the collodion is dry, which it will be in a very few minutes, the ends of the silkworm gut are tied together below. In tying, enough tension is

made to take off all strain from the sutures and to develop slight folds running from the wings of the nose to the corners of the mouth. The degree of tension may be gauged to a nicety. After the knot has been tied, one of the loose ends is thrown round the upper half of the silkworm-gut loop and tied to the other loose end. This draws the upper half down from the nostrils and the lower half up from the margin of the lip. This completes the method, and the appearance is as shown in Fig. 2. If it is found that the silkworm gut presses rather strongly on the lip, it may be wrapped with a bit of chiffon cloth and some ointment put on the chiffon cloth. The ointment will stick the chiffon cloth in place, and the chiffon cloth will adequately distribute the pressure.

The chief points of merit of this method over some others are that it permits strong retention and allows it to be accurately applied; no wound is made; no sutures are under any special tension, and thus stitch-hole infection is less likely to occur; the field of opposition is exposed to view and can be kept clean during healing. This device should be kept applied till three weeks have elapsed since operation, for it takes that lapse of time for the union to become firm enough to resist the influences which tend to broaden it. In the first case, a boy, nine months old, with a double harelip, he operated April 1, 1905, at the Post-Graduate Hospital. He utilized the premaxillary lip and caused the lateral portions to meet below it in the median line. To secure proper relaxation, he made a horizontal cut through each lateral half. He did not free the cheeks from the maxilla; silkworm gut and horsehair sutures were used. Directly after operation he washed out the stomach. When the lips were dry the retention device was applied. The sutures were removed in a week, and the retention device at the end of nineteen days. Specially notable in this case was the linear character of the scars of apposition, and the fact that this was accomplished without lifting the cheeks from the jaw to gain relaxation. The perfect retention maintained relaxation without elevation of the cheeks. The second case, a male, four months old, entered the Babies' Wards of the Post-Graduate Hospital, April 13, 1905. He had been admitted two months previously, but was then too emaciated and sickly for operation. The two intervening months he spent at Morristown and returned to the hospital much improved,

though weighing only six and one-quarter pounds. On the left side was a single harelip and a cleft through both hard and soft palates, and on the right side a cleft through the soft palate only. The gap in the alveolar process was unusually wide, and the intermaxillary portion greatly tilted out of line. The operation was done April 14. Passing a knife into the alveolar process from in front, he partly severed the premaxillary portion from the rest and partly cut the hard palate. He then elevated a muco-periosteal flap from the septum nasi in the cleft on the left side and partly cut through the vomer. By pressure he was then able to twist the premaxillary portion of the alveolar process down rather well into place. The left wing of the nose was then freed from the jaw-bone. When this had been done, it was possible to pass a silkworm-gut suture through the two margins of the alveolar process, binding together the edges of the alveolar cleft, the opposing surfaces of which were freshened before approximation. This procedure brought the nose into the mid-line of the face. The margins of the gap in the lip were then trimmed and united. As soon as this had been done, the stomach was washed and a considerable amount of blood-clot removed. For many years he has made it a practice to wash the stomach immediately following harelip operations. He regarded the removal of this blood from the stomach of these frail infants as of very great importance, and he believed that many cases not so treated die from an acute indigestion due to the presence of this blood. A few hours after operation, the retention method was applied to approximate the cheeks and take off tension from the sutures. At the end of six days the sutures were removed from the lip. In this case, also, the linear character of the scar was noticeable.

At the meeting of the Surgical Society held on May 10, Dr. Dunham again showed this case. It had gained four ounces since operation. The retention device had been removed at the end of twenty-one days, and also the suture through the alveolar process. He called attention to the fact that the alveolar process remained as it had been moulded at operation, to the linear character of the scar in the lip, to the fact that, in spite of the rather extensive work on the bony and soft parts, no infection had occurred, and he felt that these results in so frail a patient were largely due to the perfect relaxation afforded by the new retention method.

DR. BREWER recalled a case where death followed a simple operation for single harelip, and where the fatal result might possibly have been due to the cause suggested by Dr. Dunham, namely, the blood left in the stomach. The operation was done under a few whiffs of chloroform; it only occupied a few minutes, and the child left the table in good condition. There was very little loss of blood. Within six hours after the operation, the temperature rose to 106.5° F., the child became unconscious, and remained so until the end. Death was attributed to the status lymphaticus, but no positive conclusion was reached.

ACUTE HÆMORRHAGIC HEPATITIS.

DR. CHARLES H. PECK presented a man, twenty-three years of age, who was admitted to Roosevelt Hospital Medical Division, on March 30, 1905, with the following history. Two days ago patient was waked up by a sudden, sharp, stabbing pain in region of gall-bladder, not radiating, constant, increased by inspiration. With this pain he had at first headache and constipation, but no nausea nor vomiting and no cough. The pain has continued ever since severe enough to keep him awake at night. His temperature on admission was 103.8° F.; pulse, 112; respiration, 30. Physical examination showed slight dulness low in right axilla; pulmonary and cardiac signs were normal; on the following day (March 31, 1905) a few dry crepitant râles were heard in right anterior axillary line, low down. Entire abdomen was somewhat rigid; right side more so than left, especially over upper half of right rectus, where there was also tenderness. Neither liver nor spleen could be felt. A very slight icteroid tinge was noted in conjunctivæ and skin of abdomen, so slight that there was a difference of opinion as to its presence.

On April 1 there is a note that general condition was better, pleuritic râles about the same. April 2 the patient said that the pain suddenly left him during the night, its disappearance being similar to the sudden onset. Tenderness in right hypochondrium was also better. The course continued about the same, except that some tenderness developed lower down, over the region of the appendix, until the time of his transfer to the first Surgical Division, service of Dr. Brewer, on April 4, with a diagnosis of appendicitis.

On admission to the surgical ward there was no jaundice, a few râles in right axilla, some general abdominal tenderness on deep pressure, most marked over right rectus as low as region of appendix; some pain in right hypochondrium. On April 7 pain was much less; he was allowed out of bed. The diagnosis at this time was still probable appendicitis, with subsidence of acute symptoms, and appendicectomy was advised.

On April 8 there was some return of pain; temperature was then normal, 98.2° to 98.6° F.; pulse, 76; respiration, 20. Patient consented to the operation, which was performed by Dr. Seth Milliken, Jr., House Surgeon, under the direction of Dr. Peck.

On opening the peritoneum, some fresh, rather dark blood escaped, and kept oozing out from the peritoneal cavity as search was made for the appendix. Cæcum and appendix, together with an adherent portion of omentum, were drawn into the wound without great difficulty. The peritoneum of cæcum, region of appendix, ascending colon and tip of omentum were discolored by the blood in peritoneal cavity, dulled and slightly roughened, presenting the appearance of a mild, plastic peritonitis. The appendix was removed in the usual way and stump inverted; it did not appear to be diseased. A small portion of thickened, ecchymotic omentum was excised. Fresh looking dark blood continued to come from peritoneum, apparently from region of liver; no bleeding points could be found. The edge of liver could be felt through wound; it seemed very soft, blunt, and about three inches below free border of ribs; a good deal of blood followed withdrawal of finger after palpating in this region.

The appendix wound was covered and a five-inch vertical Kammerer incision made over upper part of right rectus. The liver presented in the wound; its upper surface was adherent to diaphragm in its entire extent, its under surface to transverse colon and mesocolon. The adhesions everywhere were very soft, easily separated, and uniform. The liver was uniformly enlarged, both lobes; the interlobular notch much deepened, the free edge blunt and rounded, the consistence very soft, but uniformly so. Handling of the liver and separating adhesions, though done with extreme caution and gentleness, resulted in a good deal of general oozing of blood. The gall-bladder seemed perfectly normal and was full of bile; the adhesions surrounding it seemed exactly

like those everywhere present. The pancreas was carefully palpated and felt firm and perfectly normal. The hand, swept well up between liver and diaphragm, found the same uniform, soft, adhesions everywhere, but nothing suggesting abscess or a localized process at any point. The under surface of liver everywhere presented the same condition; the enlargement, soft spongy feel, and recent adhesions seemed absolutely uniform. The liver edge was fully three inches below the free border of ribs. Blood continued to collect in region of hepatic flexure and along ascending colon in moderate amount. A large cigarette drain was carried upward to under surface of liver from appendix wound, and the rest of the wound closed by layers with catgut and silk. The upper laparotomy wound was closed by layers without drainage, with catgut, silkworm gut, and silk. Time, one hour. Condition good.

Urine examinations were as follows:

March 31. Amber, cloudy, clear; light flocculent precipitate; 1022; acid; faint trace of albumen. No sugar; no indican. Diazo reaction negative. No bile. Many hyaline and granular casts, mucus, and epithelium.

April 1. Thirty ounces in twenty-four hours. Amber, clear; light flocculent precipitate; 1026; acid; faint trace of albumen. No bile; a trace of urobilin; granular casts.

April 4. A faint trace of albumen, a few hyaline and granular casts.

April 9. No albumen, no casts.

Leucocyte counts:

On admission, 14,600; April 1, 14,200; 2, 15,200; 9, 18,000; 15, 29,000.

Differential count, polymorphonuclear, 78 per cent.; lymphocytes, 21 per cent.; eosinophiles, 0.5 per cent.; basophiles, 0.5 per cent. Red cells normal, 4,800,000.

Convalescence was uneventful; wounds healed by primary union except at point of drainage; drain was removed on the third day and replaced only through abdominal wall. A furuncle on cheek was responsible for the slight rise of temperature and high leucocyte count on the sixth day after operation. All stitches were removed on ninth day. Allowed up on the twelfth day. Liver edge could not be palpated at this time, and percussion showed dulness extending only a short distance below free

border. Patient seems to have entirely recovered and feels perfectly well.

Dr. Peck remarked that the picture that the case presented was evidently one of an acute infection, probably from absorption of some toxic material from the gastro-intestinal tract acting as a direct poison on the liver-cells through the portal circulation. The history throws no light on the possible source of this toxæmia; careful questioning failed to elicit any history of the ingestion of any unusually indigestible food, drink, or toxic substance of any kind. The attack was not preceded nor accompanied by gastro-intestinal symptoms. It presented none of the characteristics of the ordinary attack of acute cholangitis, and the condition of the liver at the time of operation, *i.e.*, uniform recent adhesions, spongy general swelling, and spontaneous oozing of blood, would indicate a process affecting the parenchyma rather than the ducts. The presence of albumen and casts in the urine, the sharp course of the temperature, and the spontaneous oozing of blood from the liver substance into the peritoneal cavity in sufficient quantity to cause a mild grade of plastic peritonitis along the line of the colon, cæcum, and region of the appendix with the accompanying tenderness which led to a diagnosis of appendicitis, all show the degree of severity of the original toxæmia, whatever the source may have been.

The diagnosis of acute hæmorrhagic hepatitis is used simply in a descriptive sense. He had been unable as yet in a very imperfect search of the literature to find any record of a similar condition, nor had the many colleagues, both surgeons and physicians, to whom he had spoken in regard to the matter, ever encountered a similar case.

RESECTION OF ILEOCÆCAL JUNCTION, THE ASCENDING, AND PART OF THE TRANSVERSE COLON FOR FÆCAL FISTULA.

DR. CHARLES H. PECK presented a man, thirty-five years old, a laborer, who was operated upon for appendicitis, with abscess, October 1, 1904; a fæcal fistula developed and has persisted ever since. An attempt was made to close it by operation on January 26, 1905, resulting in complete failure. At that time, in spite of a long and careful search and a good exposure of the cæcum and colon nearly up to the hepatic flexure, he was unable

to definitely locate the opening in the bowel; no fæcal matter escaped during the operation, which was terminated by simply establishing direct drainage down to the supposed site of the opening in the gut. Fæcal discharge continued unabated; methylene blue injected per rectum escaped promptly from the sinus, proving it to be in the large intestine.

The second operation was performed March 22, 1905.

Operation, ether. Old sinus carefully wiped out with sterile tape, and then filled with liquid paraffin injected through a silver catheter, which solidified immediately. Opening of sinus then packed with sterile gauze, and a long vertical incision made over outer part of right rectus, opening peritoneal cavity, and carried upward nearly to border of ribs. Solidified paraffin could be palpated through parietal peritoneum running upward to outer side of and behind colon, nearly as high as hepatic flexure; adhesions were separated, and the ascending colon carefully lifted from its bed and turned towards the right; at a point high in the posterior wall the paraffin was reached, where the sinus penetrated the wall of the gut; the colon was further freed in the attempt to get room to suture the opening in the bowel; during the separation of firm adhesions, a tear was made into the cæcum, and through this a stricture in the ascending colon was discovered, barely admitting the finger. Resection was deemed imperative, in spite of the poor condition of the patient. The ileum was divided about two inches above the ileocæcal junction, a segment of a Murphy button slipped into the lumen, and the end closed with a purse-string suture of heavy silk, reinforced by two tiers of Lembert's. After completing the separation of the ascending colon and hepatic flexure, ligating the vessels of the mesentery, and dividing it, the resection was made through the transverse colon, well beyond the zone of thickening and adhesions, and the diseased gut removed; it included the ileocæcal junction, the entire ascending colon and hepatic flexure, and a portion of the transverse colon. The cut end of the transverse colon was then closed by a silk purse-string suture reinforced by two tiers of Lembert's, after inserting the Murphy button in its lumen. The shafts of the button were then brought through the side walls of the gut through small incisions, and lateral anastomosis made; reinforced by a circular catgut Lembert. Operative area was cleansed with peroxide and flushed with salt solution. Two large

cigarette drains were placed in upper angle of wound and the abdominal wall closed by layers, with catgut, silkworm gut, and silk. The old sinus was not treated; the paraffin was left in place. Time of operation about one and one-half hours; the patient's condition was very poor. He was given an intravenous saline infusion of 2000 cubic centimetres on the operating table, during the resection, with marked improvement of the pulse. Also strychnine, one-thirtieth grain, by hypodermic injection.

Patient rallied nicely from the shock with very moderate stimulation. The old sinus was dressed frequently after the second day, the paraffin coming away in flakes during the first few dressings. There was never any faecal leakage; the wound healed without infection, with the exception of a small stitch abscess; the drainage opening closed rapidly. The old sinus healed more slowly, but steadily, and is now practically closed.

HÆMATURIA.

DR. F. TILDEN BROWN read a paper with the above title.

DR. ELLSWORTH ELIOT said that during the past four or five years he had observed from time to time a condition for which he could not ascribe any cause, and which, for the want of a better name, he had called idiopathic perinephritis. The condition was one in which the kidney was found embedded in its fatty capsule, and firmly adherent to its fibrous capsule. The symptoms were recurrent hæmaturia, sometimes associated with severe pain, but without albumen or other indication of a kidney lesion. In the last case that came under Dr. Eliot's observation, the bleeding recurred every day for a period of two or three weeks, and quickly disappeared after operative interference. In that case, as well as in others where the symptoms were not so pronounced, the pain and hæmaturia disappeared after division of the fibrous capsule, and suture of the outer edge of the capsule to the transversalis fascia, as was done in floating kidney.

DR. BROWN said he had seen a hæmorrhagic separation of the renal cortex from the renal capsule, but he did not recall that there was any surrounding effusion or hæmaturia associated with it. He had never met with the condition described by Dr. Eliot.

DR. LILIENTHAL said that at various times he had reported

cases where he had operated for the relief of hæmaturia, and he still held the view that, in cases of obscure hæmaturia, a nephrotomy should unquestionably be undertaken. If it turned out to be an ordinary hæmaturia, no harm had been done. In one case that was already on record, the patient was a woman whose death resulted from a pure hæmorrhagic nephritis. In her case, the cystoscope was first introduced into the bladder, but it failed to give any information on account of the free hæmorrhage. A suprapubic section was then made, and the blood was found coming in enormous jets from the right ureter. The kidney on that side was then exposed and incised into its pelvis with negative results. The patient died on the following day of acute anæmia, and at the autopsy a minute examination of the entire urinary tract failed to reveal the cause of the hæmorrhage. The diagnosis of hæmorrhagic nephritis was made after a careful microscopic examination. The bleeding in hæmorrhagic nephritis may frequently be checked by nephrotomy.

DR. BREWER mentioned a case of symptomless hæmaturia in which, upon operation, he found a beginning carcinoma. The man was still alive five years after the operation.

Stated Meeting, May 10, 1905.

DR. GEORGE WOOLSEY, President *pro. tem.*

CICATRICAL STRICTURE OF THE ŒSOPHAGUS TREATED BY THE STRING METHOD.

DR. WILLY MEYER presented a boy, three years old, who in May, 1904, swallowed some caustic lye. His mother immediately induced him to vomit; and he was then taken to a hospital, where he remained for a number of weeks, and was treated by the use of œsophageal bougies. When he left the hospital, he was instructed to report at regular intervals, which his mother failed to do.

When Dr. Meyer first saw the boy, early last November, he had a fairly tight œsophageal stricture. He had been unable to swallow solid food for some time, and was scarcely able to swallow liquids. On November 14, Dr. Meyer did a gastrostomy, following Kader's method. As the boy refused to swallow a thread, subsequently a long filiform black bougie was introduced into the stomach from above, its lower end located by means of the electric cystoscope and grasped with a properly curved forceps which had been passed through the gastric fistula. A silk thread was then pulled through from the gastric fistula out of the mouth and its ends fastened to the skin with gut plaster. A few days later a stout fish-line was attached to the string and drawn through from the mouth to the gastrostomy wound, and now the stricture was cut until a No. 32 instrument could be introduced with comparative ease. Dr. Dunham's instruments were again used to great advantage.

A second patient, also a boy of three years, was presented who had acquired his œsophageal stricture by swallowing caustic lye. The same method of passing the thread and cutting the stricture was followed in this case, and the result was equally satisfactory. The method of passing the thread from the mouth through the gastric fistula, the key to the situation, as described above, is original, and seems to represent a useful addition to our resources in these cases. It is of importance that an assistant takes hold of the end of the bougie projecting from the mouth. He will immediately feel and give notice when the forceps has grasped the gastric end of the bougie. Of course, the method is applicable to such cases only in which a filiform can be made to pass through the stricture into the stomach. Both children are in good condition to-day and able to swallow any kind of food. Both gained materially in weight. In one of them the gastrostomy wound had healed promptly after the tube was left out permanently; in the other there was still a slight leakage, which Dr. Meyer said he expected to remedy at a subsequent operation.

DR. ROBERT ABBE said that in some of these cases the strictured tissue became so firmly organized that it was a matter of great difficulty to penetrate it either from above or below. Quite recently he saw a case in which the stricture extended over a distance of three or four inches. The patient was seen by Dr. Keen, who was unable to pass even the finest filiform, and by Dr.

Deaver, of Philadelphia, who kindly referred the case to Dr. Abbe. It was impossible to enter the stricture from above, and for three days no fluid had been swallowed. After a gastrostomy, he was able to introduce a long, fine whalebone filiform from below, and within ten minutes easily cut the strictures by the string method up to the size of a large finger. He left the gastrostomy wound open, and the subsequent train of events led him to doubt the wisdom of that procedure. For two weeks he kept the wound under good control; then it began to show a tendency to pout, and was constantly bathed in gastric juice. As a result of this, the patient became emaciated so rapidly that it was necessary to do a laparotomy and close the gastric fistula by the inversion method. During this period it was necessary to intermit the dilatation of the stricture, and in ten days it had recontracted to such an extent that a small bougie could not be safely passed. Dilatation was finally again accomplished by means of a special instrument which he devised for the purpose, and has been readily maintained.

Dr. Abbe said that the first case of œsophageal stricture upon which he operated by the string method thirteen years ago remains absolutely well, and reports to him about once a year for the purpose of having the largest sized bougie passed in order to test the caliber of the œsophagus. No stricture can be detected.

DR. JOHN A. HARTWELL said that in a case of œsophageal stricture that he showed last fall, and which he treated by the Dunham method, the child at first refused to swallow the thread, but after starving him for twelve hours he consented to do so, and it was washed through the stricture without any trouble.

DR. MEYER, in closing, said that, with the exception of this one case, he had never before had any trouble with the spontaneous closure of a gastric fistula established according to Kader's or Witzel's method. The slight leakage in this instance following the removal of the tube was due to a pressure-necrosis made through the gastric fistula by the string, which had been drawn too tightly. The speaker said he was not in favor of doing the operation at one sitting; the gastrostomy should be done first, and the cutting and dilatation of the stricture subsequently.

DR. WOOLSEY suggested that the string could have been prevented from cutting the gastric fistula by passing it through the tube introduced into the gastrostomy wound.

EXCISION OF THE RECTUM FOR CARCINOMA BY THE
WITZEL-HOFFMAN METHOD.

DR. MEYER presented a woman, thirty-eight years old, who was operated on by him at the German Hospital on November 30, 1904, for an ulcerative carcinoma of the rectum, about two inches above the anus.

In undertaking an operation for this condition, Dr. Meyer said, one had to consider the Kraske method, and its modifications, and also the abdominal method in cancers situated high up. In addition to these methods, Witzel, about three years ago, advised the total excision of the lower section of the bowel without preservation of the anal ring and the formation of a gluteal anus. He claimed that any attempt made to save the lower end of the bowel by resection usually proved futile, on account of the difficulty of obtaining perfect union, and the interference with its nerve supply. For that reason, he favored excision of the lower segment, together with the diseased portion, then opening the peritoneum widely and pulling down the sigmoid.

In doing this operation, the anus is first closed with a double row of silver-wire sutures, and the os coccyx excised; the sacrum is left intact. Then the rectum is loosened posteriorly. After opening the peritoneal cavity, the inferior, middle, and superior hæmorrhoidal arteries are primarily ligated, thus obviating the danger of serious hæmorrhage. The gut can now be pulled down many inches. After tamponing carefully the free peritoneal cavity to prevent infection, the diseased section of the gut, together with the lower segment, is removed under aseptic precautions. In this instance the bowel was left within the large wound according to the modifications devised by Hoffman, one of Witzel's pupils. In the course of wound healing the stump retracted more than anticipated, necessitating a resection of the lower end of the sacrum. To-day conditions are very satisfactory. Patient has gained much in weight. In another case of this kind, operated on within the last few weeks, Dr. Meyer has closely adhered to the method laid down by Witzel, forming a gluteal anus. He has been much pleased with the result, and trusts to be able to present the patient before the Society in the fall.

SARCOMA OF THE UPPER JAW.

DR. ROBERT ABBE presented a man, seventy-two years old, who nine years ago developed a growth on the anterior part of the upper jaw, bulging forward in the canine fossa, and protruding from the right nostril.

After a preliminary simultaneous ligation of both external carotids, which up to that time, Dr. Abbe said, had not been done to his knowledge for the purpose of controlling hæmorrhage, a complete resection of the upper jaw was done. On account of the involvement of the hard palate, it was necessary to remove a large portion of the septum and a part of the opposite side of the hard palate and the inferior turbinated bone. The growth proved to be a sarcoma. There were no signs of a recurrence after nine years. An artificial plate had been substituted for the superior maxilla, greatly improving the deformity caused by the operation, and restoring speech to normal.

DR. WILLIAM B. COLEY called attention to the fact that sarcoma of the jaw often recurred after very long intervals. He recalled one case of sarcoma of the lower jaw in which there was no recurrence after five years, and another after ten years. Since the meeting, he has just seen a third case with a large local recurrence seventeen years after excision.

FINAL RESULTS IN THE X-RAY TREATMENT OF CANCER,
INCLUDING SARCOMA.

DR. WILLIAM B. COLEY read a paper with the above title, for which see page 161.

DR. ARTHUR L. FISK said that he had used the X-rays for many years upon epitheliomatous and sarcomatous growths, and that at first he had regarded the effect of the rays as beneficial, even in some cases as curative. But there had always been a subsequent recurrence, and it seemed as though the advance of this growth was more rapid, and, also, extensive, in the cases in which the X-rays had been used than in those in which they had not been used. For this reason, Dr. Fisk said, he had come to the opinion that the use of the rays was harmful even in cases which had been operated upon, because the persistent use of the rays appeared to diminish the resisting power of the tissues, in a measure to devitalize them. Therefore treatment by the X-rays

should be reserved for only the absolutely inoperable cases, and then used because of the courage and hope which the patient obtained.

DR. CHARLES N. DOWD said that he had had the opportunity of watching the work which was done at the General Memorial Hospital under Dr. Coley's direction, and that he believed that the very just and impartial statement which Dr. Coley had made was a valuable contribution to our knowledge of the value of the X-ray treatment of malignant tumors. He had seen one case of superficial epithelioma in which the X-ray treatment was very satisfactory. The patient was first seen about four years ago; she then had a small superficial epithelioma involving the ala of the nose, which had already been under treatment for two or three years. Any operative procedure would have necessitated removal of the ala, and left a decided deformity. The lesion was first treated by caustics and subsequently by the X-rays, and entirely disappeared. Eighteen months ago there was a slight recurrence, which again disappeared under the use of the X-rays, and there has been no subsequent evidence of its return.

DR. ROBERT ABBE said he was not quite as pessimistic regarding the value of the X-rays as were the previous speakers, particularly when this measure is used for the purpose of prolonging life in cases of carcinoma that were going from bad to worse. The speaker said that in one case of cancer of the lip that had disappeared with the use of Röntgen rays, three years had elapsed without a recurrence. In that instance, no microscopic examination had been made, but the clinical appearance left no doubt of the diagnosis. A strikingly beneficial effect of the X-rays was often observed in cases of advanced, ulcerating cancer of the breast which was beyond operative interference, and in which there was glandular enlargement, cachexia, hæmorrhage, and exhaustion. In one such case coming under his observation, where the patient apparently could not have survived a month, life was prolonged for two years as a result of the X-ray treatment. Under the influence of the rays, the massive carcinoma dwindled, and finally became a little flat cake of scirrhus tissue. The cachexia disappeared, the patient gained in strength, and was in the enjoyment of fair health until the following year, when there was a secondary invasion of the pleura and mediastinum, which ultimately proved fatal.

In another case of cancer of the breast, with extensive axillary involvement, in which the diagnosis was confirmed microscopically by Dr. E. K. Dunham, a very complete operation was done seven years ago. Following the operation, there was œdema of the arm for two years. Five years later a recurrence took place in the line of the scar and under the clavicle. Persistent X-ray treatment was begun, the exposures being of ten minutes each, and repeated twice weekly. Under this treatment, the recurrent nodules disappeared. Subsequently, she developed a cough, with signs of metastatic involvement of the mediastinum. She was again exposed to the X-rays, and under this treatment her cough disappeared, and the lungs entirely cleared up. For one year no physical evidence could be found in any part of the patient's body. A few days ago the woman died of acute nephritis after two weeks' illness. Autopsy made carefully by Dr. F. C. Wood showed absolutely no trace of malignant tissue in the pleura, mediastinum, lungs, liver, kidneys, or elsewhere in the body. The X-rays seemed to be particularly effective in dissipating superficial cancers, such as cancer *en cuirasse* of the breast, where it sometimes had a marvellous effect in bringing about retrograde changes in the nodules, and apparently devitalizing the cells so that they cease producing toxins, as evidenced by the disappearance of cachexia and return of color to the cheeks.

Sometimes, Dr. Abbe said, the inefficiency of the X-rays could be traced to the tube used. Some long-used tubes worked apparently well with the fluoroscope, yet a change to a brand new tube would bring about strikingly better results. We were still in comparative ignorance of the nature and possibilities of the Röntgen rays, and to discard them entirely as a therapeutic agent would be a serious mistake. We have no more right to refuse this agent to a sufferer on the ground that it does not often make radical cures, than we have to refuse gastro-enterostomy to a case of cancer of the stomach because it only prolongs life a year, but does not cure.

DR. WOOLSEY said he wished to emphasize what Dr. Coley stated in his paper regarding the harmfulness of using the X-rays prior to operation when the case was operable. The speaker recalled two cases of cancer of the tongue where valuable time was lost by giving the X-rays a trial when an operation should

have been resorted to without delay. His own experience with the X-rays in cancer had been unsatisfactory.

DR. COLEY, in closing, said he had not tried to prove in his paper that there was no value in the X-rays, but rather to combat the view that we had in the X-rays a cure for deep-seated cancer. Experience had shown that the use of the rays should be limited to the inoperable cases or to superficial epithelioma, and should never be used in deep-seated, primary carcinoma or sarcoma.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, May 1, 1905.

The President, HENRY R. WHARTON, M.D., in the Chair.

ACUTE GANGRENOUS APPENDICITIS IN TYPHOID FEVER SIMULATING PERFORATION.

DR. JOHN H. JOPSON reported an instance of this complication, with remarks upon the condition.

DR. RICHARD H. HARTE said every one recognizes the gravity of typhoid fever and also of appendicitis; when they occur together, the combination is most serious. At times it is impossible to differentiate between appendicitis and typhoid perforation. If the case is seen early and the course of the disease traced, then one may usually tell the difference, and also be able to operate early; this, however, the surgeon rarely has the chance to do. Symptoms in typhoid perforation are usually more marked, coming on with flash-like rapidity, while appendicitis is commonly more insidious. Both demand immediate operation. Concerning rules for waiting in these cases as quoted and endorsed by Dr. Jopson, Dr. Harte is not in accord. Waiting is a rather dangerous procedure. Marked irritation in the right iliac fossa developing during typhoid fever is often attributed to appendicitis, and the physician waits in the hope that these symptoms will subside. But if, instead of appendicitis, typhoid perforation has occurred, the abdomen should be opened immediately; every fifteen minutes means the loss of chances for saving the patient's life. Dr. Harte has noted that, in cases operated on immediately after perforation, the recovery rate is much greater than when intervention is deferred. For this reason a

waiting policy possesses elements of danger. If appendicitis be actually present, the uncertainty is still greater. Hence, if during typhoid fever the diagnosis of appendicitis is made and the symptoms of perforation develop, the abdomen should be opened as soon as possible. Unless he misunderstood Dr. Jopson's quotation of Kelly's statements regarding the frequency of appendicitis in typhoid fever, Dr. Harte does not find them supported by his experience. He has operated in quite a large number of cases of typhoid fever, and does not consider appendicitis so frequent as some writers would lead one to believe. The surgeon cannot say absolutely that appendicitis is present during typhoid fever unless he operates. Dr. Harte has found very few instances of appendicitis among the cases of typhoid for which he has operated, although he and his colleagues at the Pennsylvania Hospital have operated for this condition during the course of typhoid. In thus speaking about operation, it is recognized that every operator knows the gravity of opening the abdomen of a typhoid patient, and desires to avoid it if possible. All the existing conditions are such as to render operation a very grave procedure. In twenty-six abdominal sections for typhoid perforation, Dr. Harte has made the error of operating in two cases when perforation was not present; fortunately, both patients recovered.

DR. JOHN H. GIBBON said that he had operated upon two cases of appendicitis during typhoid fever. In one case it could not be demonstrated that the condition was the result of typhoid ulceration of the appendix. In the other, however, there were three distinct typhoid ulcers of the appendix, one being at the base and completely occluding the lumen of the organ. It is thought that in this latter case there might have been no cause for operation had there been no obstruction of the appendix. The first case was operated upon for one of perforation, but in the second case it was not thought that a perforation was present, but the symptoms were sufficiently marked to warrant the opening of the abdomen. In the case reported by Dr. Jopson, a noticeable fact is that, although the temperature dropped, the pulse fell from 144 to 128, which does not usually take place in a perforation of the intestine. Dr. Gibbon believes that a differential diagnosis of appendicitis during typhoid fever and perforation of the bowel is extremely difficult, yet in the former

condition the symptoms are never so sudden and severe as in the latter.

DR. W. JOSEPH HEARN endorsed the statements of Dr. Harte regarding the need for early operation. If the general symptoms usually accompanying perforation are marked, whether they are due to typhoid perforation or gangrenous appendicitis, the sooner operation is performed the better it is for the patient. Dr. Hearn usually gives intravenous infusion of saline solution and then at once operates. In a proportion of cases this is successful, though he has also lost many cases. Operation will be successful if performed in time. The rule to be followed is not to wait.

DR. JOPSON, in closing, said the figures relating to involvement of the appendix during typhoid fever needed explanation. In 119 cases of typhoid reported from Boston and Baltimore, there was macroscopic evidence of involvement of the appendix in 19. The other statement that one-third of the cases was involved referred to the microscopic picture afforded by the appendix. As to the diagnosis of appendicitis from perforation, many cases of appendicitis come on early in the course of typhoid when irritation in the right iliac fossa is greater than can be attributed to the latter disease. Operation is then safest and intestinal perforation can be excluded because of the early stage of typhoid. Waiting at this time is also more justifiable than at any other. At this stage most mistakes in diagnosis are made. Differential diagnosis in cases such as the one reported is not necessary, even though desirable. There is no way of distinguishing the two conditions except by the preceding history, and even that is liable to lead to mistake as in this case, where symptoms of appendicitis came on as rapidly as they do in perforation during typhoid fever; gangrene and rupture seemed to be almost simultaneous with the pain. The age of the child and the generally bad condition of the intestine doubtless favored gangrene.

FRACTURE OF THE HEAD OF THE TIBIA.

DR. HENRY R. WHARTON reported the case of a man, aged fifty-five years, who was admitted to the Presbyterian Hospital, June 24, 1902, having fallen from a bicycle and injured his left knee. When seen by the reporter, a few hours after his admission, the left knee and upper portion of the leg were swollen

and painful. An examination revealed a fracture involving the outer portion of the head of the tibia. There was marked effusion into the knee-joint and adjacent bursæ. The patient suffered great pain, which seemed entirely out of proportion to the extent of the injury, and was probably due to the associated synovitis. He stated that when he fell from his bicycle he landed upon the left foot, and his body was rotated, when he felt something give way in the region of the knee. An X-ray examination showed that there was a separation of the triangular piece of the outer portion of the head of the tibia, with upward and outward displacement of the fragment, necessarily involving the knee-joint.

The limb was placed in a long fracture-box and the region of the fracture was treated by the application of lint saturated with lead-water and laudanum, and after a few days, when the swelling to a certain extent had subsided, a plaster-of-Paris dressing was applied. This dressing was used for six weeks, and after this time the patient began to use his crutches, and at the end of ten weeks was able to walk with the aid of a cane. He had at first very limited motion of the knee-joint, but this improved with use, and finally he regained good use of the limb.

An examination of this case eighteen months after the injury showed that he walked well, but still had some impairment of joint motion at the knee. Extension was perfect, but he could not flex the knee beyond a right angle.

A second case was as follows: A baggage-master, in throwing a bundle of papers from his car while the train was upon a curve in rapid motion, was thrown from the car, striking upon both feet, receiving injuries of both legs which prevented him from rising from the ground. He was admitted to the Presbyterian Hospital, May 29, 1904, several days after the accident. An examination showed that the right leg and knee were greatly swollen; there was also marked swelling in the region of the left ankle. A fracture was located at the outer portion of the head of the right tibia. There was also marked effusion into the right knee-joint and adjacent bursæ. Great pain was complained of in the region of the knee, which was much increased by pressure and attempts to move the joint. An X-ray examination showed fracture of the outer portion of the head of the

tibia, involving the joint; no injury of the bones could be discovered at the left ankle.

This patient was treated by a plaster-of-Paris bandage extending from the toes to the upper portion of the thigh. The patient left the hospital at the end of a month, still wearing the plaster-of-Paris dressing.

An examination of this case nine months after the accident showed firm union in the fracture, but still some impairment of the joint motion in flexion. The patient, however, has a useful limb.

A third case of the same injury was as follows: A man, aged forty years, was admitted to the Presbyterian Hospital, February, 1905, having sustained an injury of the left leg in wrestling. He stated that he fell from a step a distance of a few feet and struck upon his left foot, his body twisting as he struck the ground, and he felt something tear in the region of the knee, and fell over helpless.

When seen by Dr. Wharton, a few hours after his admission, he was suffering intense pain in his left limb, which was very much swollen, and the knee-joint and adjacent bursæ were swollen and tense. An examination disclosed crepitus at the head of the tibia, near the knee-joint. An X-ray examination revealed fractures of the external portion of the head of the tibia and of the internal tubercle of the tibia, with involvement of the knee-joint, and upward and outward displacement of the external fragment of the tibia.

The limb was treated in a long fracture-box for a few days, with the application of lead-water and laudanum. For the first few days the pain was so great that morphine had to be freely used to give him any ease. At the end of this time, under anæsthesia, attempts were made by manipulation to press the displaced fragments inward and downward. The limb was then put up in a plaster-of-Paris bandage, including the foot, and extending to the upper portion of the thigh. The patient was more comfortable with this dressing, but suffered at times from severe attacks of pain, which he said came on suddenly, the pain radiating from the knee, up the thigh, and downward to the leg. These attacks were so severe at times that morphine was required.

At the end of seven weeks he was allowed to get up on

crutches, but after being up for a day he noticed that the foot became hot, and presented a superficial, burning sensation. On inspection it was found that the toes on the dorsum of the foot were markedly discolored, and were hot and painful to the touch. Upon removing the plaster-of-Paris bandage, it was found that the redness extended well up upon the dorsum of the foot, and to some extent involved the skin over the ankle, the plantar surface of the foot being neither painful nor discolored, and there was no swelling of the foot. There was no paralysis, the patient being able to flex and extend the foot. He also suffered from severe attacks of pain in the region of the fracture, which passed from the patella to the inner portion of the thigh and also the leg and foot. These paroxysmal attacks of pain were so severe that no relief could be obtained until morphine was given hypodermically.

From the distribution of the pain and the location of the trophic disturbances, it was thought that the external popliteal nerve was probably caught by the displaced fragment, or was pressed upon by callus, and after consultation with Dr. Willard, it was decided to expose the nerve for the relief of this condition. The patient was anesthetized, and upon examination of the joint it was found that the knee could be flexed to a little more than a right angle. The nerve was then exposed by an incision, and the trunk laid bare for about three inches. It was found that it was not pressed upon by the fragment nor pinched by callus. The upper half of the exposed nerve was normal in appearance; the lower half, to a point where it passes over the peronæus longus muscle, was enlarged and of a deeper color, and the sheath was thickened and contained some reddish serum. The sheath was opened and the nerve was thoroughly stretched. The wound was closed and dressed, and the limb was placed in a posterior binder's-board gutter.

The pain after the operation was very slight, one dose of morphine only being required. The discoloration of the foot and ankle has gradually diminished, and at the time of the report, more than two weeks after the operation, the foot has resumed its natural color.

Dr. Wharton remarked that fractures of the head of the tibia involving the articular surface present several points of interest. First, as regards the mechanism of these fractures. As

far as he could learn, they usually result from a fall upon the foot, in which there is a rotation of the body, with twisting of the knee. Another point of interest is the extreme pain accompanying these fractures, probably due, in fractures involving the external tubercle, to injury of the external popliteal nerve and the rapid effusion which occurs into the knee-joint and adjacent bursæ. The pain and trophic disturbances may occur immediately upon the reception of the injury from injury of the nerve at the time, or may follow later from pressure upon the nerve by a displacement of the fragment, or by callus. In the last case reported, it is interesting to note that the trophic disturbance seemed to be confined to the distribution of the musculocutaneous nerve rather than to that of the anterior tibial nerve, as there was at no time paralysis resulting in foot-drop. Stimson states that fractures of the head of the tibia are slow in repair, and quotes seven cases recorded by Poncet in which the average time of union was about four months.

Restoration of function after these fractures is seldom complete, the occurrence of synovitis and arthritis, with backward displacement of the fragment, interfering with the normal joint motions of the knee. Extension is usually normal, but there is generally more or less interference with complete flexion of the joint. Repair is probably much less prompt than in fractures involving other portions of the tibia.

DR. JOHN H. JORSON briefly described a case now under his care which corresponds very closely to those reported by Dr. Wharton. The patient is a railroad man, who, while superintending the shifting of cars in the dark, stepped out of a door, six feet from the ground, in the direction the train was moving. He lighted on his feet on loose ballast, and one leg immediately went from under him; there was severe pain in the knee and inability to rise. The mechanism evidently consisted in turning and twisting the leg at the time it struck the ground with considerable force. There was effusion of blood into the joint and underneath the bursa of the quadriceps. When seen several hours later, the patient still complained of severe pain, and there was tenderness over the knee, especially on the outer side. Crepitation could not be elicited, and there was neither shortening nor irregularity. The condition was thought to be laceration of the lateral ligament, but a week later the X-ray showed

a small oblique fracture of the outer part of the head of the tibia running down from the joint, and thus splitting off a fragment of the bone. Pain in the knee persisted for three or four weeks until a final immobilization with plaster-of-Paris dressing. Now, at the end of six weeks, there is no pain, and the patient appears to be doing well; the final result cannot of course be predicted.

SUTURE OF THE FEMORAL ARTERY.

DR. EDWARD MARTIN reported the case of a man, twenty-three years old, who was admitted to the University Hospital, May 18, with a history of having been wounded the day before by a piece of steel chipped off from a side set by the blow of a ten-pound hammer. There was an immediate profuse bleeding, the blood spurting to a distance of two inches. This was controlled by means of a tourniquet. There was found a wound about half an inch in length at the junction of the middle and lower third of the left thigh directly over the course of the femoral artery. On the removal of the tourniquet there was no further bleeding; the wound was thoroughly cleansed and a sterile pad was held in place by means of a tight bandage. During the night there was a moderate degree of oozing, and examination the following day showed a tumor about the size of a man's fist, fusiform in shape, giving an expansile pulsation and a harsh bruit. Popliteal and tibial pulsations were absent. A tourniquet was applied at the level of the perineum and a 17-centimetre incision was made with its centre of the wound of entrance. On opening the deep fascia a large thrombus was found, to the outer side of which lay a small jagged piece of steel. There was in the anterior surface of the femoral artery a ragged wound 2 centimetres in length opening into the lumen of the vessel. The artery was freed above and below and a loop of large gut was thrown about it in each position. The tourniquet was then removed, bleeding being controlled by traction upon the loops, which also rendered the vessel more accessible to suture. Fine curve-faced needle and No. 0 chromicized gut and No. 8 silk were employed for the sutures, five of which were applied. On relieving tension, there was a spurt of blood at the most ragged part of the wound, requiring the insertion of a sixth suture. On removal of the traction ligatures the artery pulsated below. The

fascia was sewn above it with chromicized gut sutures. Drainage was inserted, since it was quite certain that the wound had been infected by the foreign body. The external wound was closed. The patient made an uninterrupted convalescence, pulsation being detected in the popliteal artery on the following day, and remaining thereafter.

Dr. Martin said that the interest attaching to cases such as this is incident to the fact that the opportunity of suturing a large artery rarely occurs in the course of surgical practice, since such wounds when accidentally inflicted are in themselves unusual, and when they do occur are likely to be attended by bleeding so profuse as to be fatal before aid can be rendered.

Although medical literature contains a number of instances of attempts at sewing both arteries and veins, Murphy was the first to thoroughly popularize the method by a series of brilliant experiments, and, finally, by a clinical experience which still remains the most striking practical demonstration of the practical utility of the method. The common femoral artery had been almost completely severed by a bullet. This vessel was resected, and the proximal end was invaginated into the distal for a distance of one-third of an inch by means of four double-threaded needles which penetrated all the coats of the artery. A row of sutures was then placed around the distal end, penetrating only the media of the proximal portion, after which the adventitia was drawn over the line of union and sutured. A wound of the vein inflicted at the same time was also sutured. Convalescence was uninterrupted, the patient making a complete recovery.

In the experimental work on this subject, there has been more or less insistence upon the need of avoiding the intima in the placing of sutures. This, however, seems to have no bearing upon the formation of clot, which is always possible, and which, perhaps, in the majority of cases may be expected, though Dörfler, in a collection of forty-three experimental cases in which the intima was included in the suture, noticed that there was thrombosis in but five.

Brewer, in attempting to close a wound in the femoral artery, noted that the sutures tore out, and was led to a suggestion which has been attended with considerable success, namely, the application of rubber adhesive plaster about the vessel, the outer wall of which is previously dried by swabbing with ether.

Experimentally, this method served admirably, though it is noteworthy that thrombosis occurred at times.

In the application of sutures to a wounded artery, the needles should be round, pointed ones, and of such diameter that the thread which they carry fills the holes made by them. The immediate bleeding of the suture points is overcome by the use of catgut, though silk is the suture material of choice. No effort should be made to avoid the intima, though the inclusion of this coat in the suture does not add materially to the strength of the union. In attempting to prevent the entrance of the needle into the lumen of an artery, there is danger that the tough media may not be included, and thus the line of union may almost immediately tear out from the effect of blood-pressure. For a partial cut or tear the continuous suture is preferable.

The likelihood of thrombosis is in direct proportion to the amount of damage done to the intima, hence the artery should be handled gently, and the least possible mechanical interference compatible with its proper stripping and exposure, and the application of the suture should be the rule. Infection is almost certainly followed by thrombus, and of course exposes the patient to the danger of secondary hæmorrhage. Of this, however, there is now little fear. The line of suture should be reinforced by stitching the adventitia closely about the artery, and moreover additional support should be given by a suture of the overlying soft parts.

For end-to-end closure the invagination method of Murphy has proven successful. Its application is also easy.

Perhaps the most surprising feature of these artery sutures is the fact that there has been no case of aneurism yet reported, though more than two dozen clinical cases are on record. There are comparatively few positions in which such a procedure as suture of an artery is absolutely essential. In all the smaller vessels complete ligation would be the method of choice. When the carotid artery is wounded, its ligation is so often followed by secondary cerebral degeneration that an attempt at suture is clearly indicated. The common femoral is also a vessel which should be sutured, though even in this case, providing the vein remains intact, the danger of gangrene is comparatively slight. The abdominal aorta is essentially a vessel fitted for suture in case of wound. Theoretically, at least, a suture or invagination

of the renal artery, or of the superior mesenteric, may at times be feasible, or in the latter case even the implantation of the divided end of the vessel into the aorta. The possibility of closing a wound of the artery also suggests for consideration the desirability of opening these vessels in cases of threatened embolic gangrene.

DR. FRANCIS T. STEWART reported the case of a man, aged thirty years, who was struck on the inner side of the right thigh by a small piece of steel, which penetrated the tissues, leaving a slit-like opening in the skin about one-fourth of an inch long. When admitted to the Germantown Hospital shortly afterwards, there was still considerable bleeding, although a tight bandage had been wound around the limb. When Dr. Stewart saw the patient the following day there was no bleeding and no swelling of the thigh. Several X-ray pictures failed to locate the piece of steel. Eight days after the accident, during the night, the patient was awakened by severe pain in the region of the wound. The thigh rapidly swelled, and pulsation soon became evident both to the eye and to the hand. There was no external bleeding, no thrill, and no bruit. Pulsation could be felt in the anterior and posterior tibial arteries. Twelve hours later a long skin incision was made along the course of the femoral vessels. The upper end of this incision was deepened until the femoral artery could be compressed between the fingers of an assistant. The artery was then traced downward to the middle of Hunter's canal, where a ragged opening about one-eighth of an inch in diameter was found. The artery was then grasped distal to the wound by the second hand of the assistant, and the wound was closed by a continuous silk suture penetrating all the coats of the vessel, an intestinal needle being employed. A second continuous suture of silk involving the sheath of the vessel was applied for a reinforcement. No leakage being detected after the removal of compression, the muscles were sutured with catgut and the skin closed with silkworm gut, drainage being omitted, although the tissues were extensively infiltrated with blood. The leg was maintained in an elevated position for two weeks. The wound healed without infection. The anterior and posterior tibials pulsated with undiminished force from the time of the operation until the patient left the hospital.

Dr. Stewart added that it was interesting to note that in

1759 Hollowell successfully closed a wound in a brachial artery following venesection by passing a needle through the lips of the wound and tying a silk ligature beneath the needle. In 1762, Lembert proposed arterial suture and experimented on the horse. Following this, however, repeated experiments on animals seem to demonstrate that uncontrollable bleeding from the stitch-holes would occur, that a thrombus would form at the point of suture, or that sepsis and secondary hæmorrhage would follow. It was also feared that an aneurism might develop at the line of suture, or that a clot embolus might be washed into the circulation. In 1889, Jassinowsky showed by a large number of experiments on dogs and calves that these accidents were not to be feared. Most operators have followed his plan of operation, which is as follows: Control of the circulation. Isolate artery and push the sheath back. Suture the media and adventitia with interrupted sutures of fine silk. Take off the clamps with simultaneous compression of the vessel wound. Sew the sheath, then the fascia, then the skin. The continuous suture is believed to be preferable because of its rapidity, and because there is no tendency towards leakage between the points of insertion; and that a suture involving all the coats of the artery is preferable, because it is easier to apply and much more sure to hold. Hubbard (*Boston Medical and Surgical Journal*, vol. xlvi, 1902), in an article in which he collects twenty cases of arterial suture, states that in five cases a suture involving all the coats was successfully employed, and quotes Dörfler, who demonstrated experimentally that a suture passing through the intima would neither cause bleeding nor thrombosis.

DR. RICHARD H. HARTE advised trial of suture in case of wound of the femoral or of any other large artery; if this fails, ligation can later be performed. He had seen a hospital resident wound the iliac artery with a Hagedorn needle while assisting at an operation for hernia. Hæmorrhage was profuse, the blood spurting a distance of eighteen inches. Dr. Harte exposed the vessel at once and sutured it with silk. The man did well, the case, of course, being much more favorable than was that of Dr. Martin's. Some weeks later the man died from another condition, and inspection of the wound showed that repair of the vessel was perfectly satisfactory. Hence he would not hesitate to suture a vessel, as he believes this to be good surgery. The

opportunity seldom presents, but when it does, it should be met by suturing.

DR. DE FOREST WILLARD said that Dr. Brewer's work upon the suture of arteries is a most valuable contribution. Although wrapping the vessel with rubber tissue introduces into the body a foreign element, yet Brewer's reports are very satisfactory. Dr. Dorrance, of the University of Pennsylvania, is now conducting experiments for Dr. Willard, employing, instead of rubber tissue, flaps of fascia to enclose and support the wounded vessel. It is yet too early to draw conclusions, but present indications are that this method will prove of value. By this means it may be possible to succeed in closing vessels whose walls are not strong enough to hold the sutures or the edges of which are too ragged to approximate. The fascia is, of course, left with a base of attachment to preserve its vitality.

DR. MARTIN, in closing, emphasized the facts that a growing clinical experience has failed to demonstrate a single case of aneurism following suture of the large arteries. The absence of secondary hæmorrhage and diffuse traumatic aneurism is equally astonishing. It still remains to be proven that in the human either partial or complete wounds can be sewn with an absolute assurance against thrombus, and it is doubtless true that in many of the successful cases reported thrombi formed. However, the possibility of opening even the largest vessels, such as the aorta, and closing them again with safety, suggests a variety of forms of intra-arterial surgical interference, particularly in the direction of preventing gangrene in cases of embolic plugging. Indeed, this has been once attempted because of threatened gangrene of the leg. It is conceivable that an extraordinarily prescient surgeon might thus relieve one suffering from the early stages of mesenteric embolus.

A NEW METHOD FOR IMMEDIATE ENTEROSTOMY.

DR. FRANCIS T. STEWART said that in cases of enterostomy in which immediate opening of the intestine is mandatory, there is considerable risk of infection of the peritoneal cavity by faecal contamination. The packing of gauze around the loop about to be opened sometimes averts this danger. Careful suturing of the bowel is an expedient which may succeed, but in cases in which the intestinal wall is stretched and thinned by marked dis-

tention it is practically impossible to insert a needle in the bowel wall without entering the lumen and causing leakage. Up to the present time the Paul's tube or one of its modifications has been the best means for safely draining the intestine in these cases. During the past winter he had employed the following method in three cases, two of which died shortly after operation. After opening the abdomen, the desired loop of bowel is drawn into the wound and emptied of its contents by a gentle milking process. A clamp is then placed at either extremity of the loop to prevent the reflux of fæces into it, and the whole is surrounded by gauze packing. One-half of a Murphy button is inserted into the empty loop of the intestine through a small incision, and the other half is squeezed into the end of a long rubber tube whose caliber is slightly smaller than that of the flange of the button, thus making a tight joint. The two halves of the button are then pressed together, or, in other words, a lateral implantation is made between the rubber tube and the bowel. The clamps are now removed and the fæces allowed to drain through the rubber tube into a receptacle on the floor. Whether a bar has previously been placed beneath the bowel or not, the intestine should be securely fastened to the margins of the wound by sutures in order to prevent the prolapse of any additional coils of intestine; with a collapsed bowel, the sutures may be introduced without fear of leakage. By this method an absolutely air-tight joint is made between the bowel and the rubber tube, so that the intestine is drained without the slightest possibility of infection of the peritoneal cavity. By the time the button has sloughed through the bowel (at the end of the third day in his surviving case), adhesions will have effectually closed the peritoneal cavity. The dressing need not be distended until the button comes loose.

VOLVULUS OF THE OMENTUM.

DR. FRANCIS T. STEWART said that in a paper read before the College of Physicians, November, 1903, he reported a case of torsion of the omentum, and appended an abstract of eight other cases. Since then, Rudolph (*Wiener klin. Rundschau*, 1903, Nos. 44-47) has collected twenty-nine cases, of which twenty-three were intra-abdominal. He states that in one case only was the exact diagnosis made before operation. Sonnenburg (*Arch. Internat. de Chirurgie*, vol. i, fasc. 1), Noble (*American Jour-*

nal of Obstetrics, 1904, vol. xlix), and Scudder (*ANNALS OF SURGERY*, December, 1904), have also reported cases. These, together with the present case, make thirty-three thus far reported. A hernia was found in all cases except five. He now was able to report a second case. The patient was a policeman, aged thirty-four years, and weighing 250 pounds, who entered Professor Keen's service in the Jefferson Hospital, April 8, 1905. Up until three years ago he was in the best of health; every few months since that time he would experience a sharp attack of indigestion, with severe pain in the abdomen. For the past fifteen years he has had a reducible inguinal hernia about the size of a lemon on the right side, which has never bothered him, and for which he has never worn a truss. Just after breakfast, the day preceding admission to the hospital, he felt one of his attacks approaching, the pain, however, being more severe than usual. On admission to the hospital there was severe abdominal pain, especially on the right side. The greatest point of tenderness was just below and to the right of the umbilicus, rigidity of the abdominal muscles was general, but especially marked on the right side. Owing to the thickness of the belly-wall and to the rigidity of the muscles, no mass could be felt, although the right side seemed to be slightly more prominent than the left. The hernial sac was empty. The temperature was 98.5° F.; pulse, 90; respirations, 20; there had been no vomiting; the bowels had moved the previous day. A diagnosis of acute appendicitis was made and the abdomen opened thirty hours after the onset of pain. After some difficulty, the appendix was found between the layers of the mesocolon and excised. It measured six inches in length and, except for several ecchymotic spots in the mucous membrane, was normal. A further search of the abdomen brought to light a mass of omentum, dark red in color, much harder than normal, and evidently in the first stage of gangrene. On pulling the omentum from the abdominal cavity, a twist consisting of three complete turns from the patient's right to left was found just below the transverse colon. After amputation, the spread-out mass measured twelve inches longitudinally and fifteen inches transversely, and weighed one and one-half pounds. At its free edge the omentum presented five large pockets, due to a folding over of the edge with subsequent adhesions. The abdomen was closed without drainage, and the patient made an uninterrupted recovery.

TRANSACTIONS

OF THE

CHICAGO SURGICAL SOCIETY.

Stated Meeting, April 3, 1905.

The President, DR. L. L. McARTHUR, in the Chair.

CARCINOMA OF THE LIVER.

DR. L. L. McARTHUR showed a patient that had been exhibited to the Society on former three years. The first time was during the Presidency of the late Dr. Christian Fenger. The patient had been referred to him by Dr. Favill, with symptoms of ulcer of the stomach. There was difficulty attending the differentiation between ulcer of the stomach and malignant disease of that organ. After long-continued lavage, etc., the patient was transferred from the medical to the surgical ward of St. Luke's Hospital to the speaker's service, and operative intervention resorted to. The operation disclosed a tumor of the lesser curvature of the stomach, which had grown into the under surface of the left lobe of the liver, requiring excision of a wedge-shaped piece of the liver and a wedge-shaped piece of the lesser curvature of the stomach. Specimens were examined by the pathologists, Drs. Hektoen and Zeit, and the disease was pronounced adenocarcinoma. When the speaker presented the microscopic specimens to the Society three years ago, Dr. Fenger, on examining them, pronounced the disease indubitable carcinoma of the stomach invading the liver, without any limiting membrane whatever, therefore not an adenocarcinoma, as the latter always pushed the capsule before it. The diagnosis was then revised by Drs. Hektoen and Zeit as a carcinoma proper of the liver.

The patient was presented again for the fourth time, not because he was still alive (death had been predicted to take place in a short time), but because in the past year symptoms of ulcer

of the stomach had again recurred and patient was again referred to him. On making an exploratory section he found that there was no recurrence of the disease at the seat of the old scar; that there were no new growths to be detected in the liver nor in the stomach wall, so he made a gastro-enterostomy by the anterior method, but perforating the gastro-colic omentum and carrying the knuckle of bowel posteriorly to the stomach, in front of the colon. The man had again been relieved of the symptoms of ulcer, and had gained thirty pounds in weight. Patient was an orderly at the hospital, and was again on duty attending to his work.

LYMPHATIC AND HEPATIC INFECTIONS SECONDARY TO APPENDICITIS.

DR. JOHN C. MUNRO, of Boston, Mass., read a paper with the above title.

DR. JOHN B. MURPHY said that his experience had been very small so far as infections from the appendix in association with the portal vein are concerned. If we take the type of various infections as a standard, we conclude by comparison that infections from the lymphatics take place rapidly; that infections through the portal circulation to the liver take place slowly, as infections through the lymphatics take place rapidly after the primary infection, that is, before there is a local immunity through occlusion of the lymphatics by the infiltration, which, however, does not always occur. The most striking example of absence of local infiltration (immunity) he ever saw was recently in a case he observed at Elgin, Illinois, with a history resembling perforative peritonitis that began on Friday, two days previous to operation. The symptoms immediately following intense pain were vomiting, cyanosis, great cardiac depression, which continued from the time of onset of the pain until two hours before operation. There was no sensitiveness in the area of the appendix; there was sensitiveness in front of the tip of the right costal cartilage extending downward. The question arose in his mind, Why should this patient be collapsed; why cyanotic, as he was a young, vigorous man, and why should vomiting persist in a case of ordinary appendicitis? His diagnosis was fat necrosis. The diagnosis advanced by the attending physician, Dr. Whitman, was appendicitis. The leucocyte count showed 29,000, which con-

tra indicated fat necrosis, and this caused the speaker to waver in the diagnosis. Upon opening the abdomen he found gangrene of the appendix, no perforation, and no peritonitis, and *not the slightest infiltration of the meso-appendix*, the first time he had ever seen this, notwithstanding the fact that it was forty hours after the onset of the infection. Why was there an absence of infiltration in the meso-appendix? Infiltration means local immunity, local resistance to the absorption of infective products. Here there was no local immunity. Here were all the symptoms of intense sapræmia, and they corresponded exactly with the pathologic findings, because there was no local resistance offered by the lymphatics, which accounted for the intensity of the collapses from the infection. On examining the upper part of the abdomen, there were no evidences of involvement of the pancreas or liver; there was no local obstruction to the lymphatic flow. When pus infections are transmitted to the liver through the portal circulation, we must have a secondary process before we can have hepatic infection; we must have thrombophlebitis and escape of the infective material into the liver.

He had had two cases of pylephlebitis, in which the diagnosis had been made and verified by postmortem: one following operation for appendicitis and the other following an operation for hemorrhoids. Ten days after the hemorrhoidal operation, the patient had chills and fever, which were characteristic; namely, chills, with sudden elevation of temperature, the temperature remaining high for a time, then dropping down to normal. There was no regularity about it. It was typical of hepatic infection, whether that infection was from the lymphatics, from an impacted stone in the cystic or common duct, or from the portal vein. He saw this case in consultation six weeks after the operation for hæmorrhoids. The diagnosis was made on the clinical course of the chills and fever, and not on the physical findings. The necropsy showed the direct tract of infection from the hæmorrhoidal area to the portal vein and the secondary multiple abscess of liver and spleen. The other case occurred in a child within the last year that had been operated for appendicitis. The temperature was normal for forty-two hours after the operation, and then it began to rise. A diagnosis of pylephlebitis with hepatic infection was made, and post-mortem examination verified it.

The question of how the lymph circulation carried infection

into the substance of the liver was interesting, and some light has been thrown on this recently by the work of Terrier and Cunéo on the lymphatics. These authors have demonstrated beyond question that in certain areas of the liver, and particularly on the lower and costal surfaces of the right lobe, we have lymphatics, not taking the usual general course from the surface of the liver beneath Glisson's capsule, extending to the suspensory ligament, or extending to the sublymphatic glands around the gall-bladder, but passing directly from the surface into the liver and along the portal vein to the hilum. If these lymphatics take this course, as there is every reason to believe they do, one can readily see how an infection extending to the under surface of the liver from the appendix, either by direct lymphatic transmission or along the surface or side of the colon, could immediately infect the lobe of the liver and form an abscess. This is the most elucidating information which he has received up to the present time. He had seen on one occasion the appendix with a peri-appendiceal abscess adherent to and involving the under surface of the liver, but not extending into the parenchyma.

DR. E. WYLLYS ANDREWS recalled the paper read about a year ago by Dr. Le Conte, on the subject of rupture of the mesenteric glands simulating typhoid perforation. This belonged to the category of atypical cases, the source of the infection being a typhoid ulcer, producing lymphadenitis and suppuration in the gland, with rupture of the abscess into the peritoneal cavity, which simulated closely perforative typhoid, causing subdiaphragmatic abscess, violent infection, and collapse. Since reading this paper, two cases had occurred here, one in the speaker's own practice, and one in the practice of a colleague. The abdomen was opened under the suspicion that he had a perforating typhoid, and the true condition was that of a retroperitoneal abscess bursting through into the peritoneal cavity. He thought it was impossible to make a differential diagnosis between this condition and typhoid perforation before operation.

Two cases of pneumococcus peritonitis also occurred, one in the County Hospital and one at Reese Hospital. Both were marked by an absence of distention, ileus, or the ordinary signs of diffuse peritonitis. Both ended fatally.

DR. L. L. McARTHUR reported the following cases in his own experience. First, as a type of hepatic infections probably portal

in their origin was a case referred to him by Dr. Collins of this city; seen by Dr. Collins first at about ten o'clock at night, diagnosed as an acute gangrenous appendicitis, and operated by him and the speaker at about five in the morning, a gangrenous appendix being found and removed, as yet unruptured, but in a condition so that migration of the organisms was possible through the dead and gangrenous wall of the appendix. However, it was deemed safe to close the abdomen with a small drain in case there had been a passage of micro-organisms through the intact but dead wall of the appendix. There was a normal, satisfactory convalescence, the patient being up on the tenth day, when symptoms of a low grade of fever, without any local symptoms, developed. Two consultants were inclined to regard it as an atypical typhoid, because a Widal was reported from the Health Department, and a partial Widal at the hospital examination. The temperature rose higher and higher for three or four days, until it reached 106° F., with violent rigor. In a state of desperation, in the absence of any local guide, the speaker inserted a Dieulafoy aspirating needle of good size into the right lobe of the liver, and fortunately struck a cavity containing stinking pus. The trocar was left *in situ*, and the patient taken to the operating table. After aspirating a sufficient quantity of pus to reduce the abscess pressure, the liver was exposed along the track at which the needle had entered (between the tenth and eleventh rib on the right side), finally exposing the abscess, which was opened and drained, the patient making a good and prompt recovery. The temperature dropped, and all symptoms became normal in a brief time, with this exception, there was a persistence for six months afterwards of a biliary fistula, evidently a large bile tract having been cut off by the large abscess. As long as the tube was left *in situ* the patient was well, up and around, and gained in weight. Once or twice the removal of this tube was attempted, but each time a rise of temperature required its reinsertion. The patient drifted away from the hospital. He returned after three months, with a suspected retention in the old abscess. Operation was made, but no abscess was to be found. The abdomen was opened, the gall-bladder region and subhepatic region explored, the liver explored by multiple puncture, but no abscess found. Death ensued nine months after the appendectomy, which, by the way, made no further trouble, and at the post-mortem examination it was found that a small abscess not

much larger than an almond had formed apparently in the lymphatic gland behind the common duct and internal to the usual position of these lymphatic glands at the hilus of the liver.

He thought it uncertain whether in this case the infection came from the hepatic area along the venous channel, and whether death finally ensued from this solitary abscess in the lymph-gland at the hilus of the liver, or whether a secondary infection from the liver to this lymphatic gland had occurred.

One of the most striking types of infection of the portal circulation was seen by him in a case in connection with Dr. Billings and Dr. Bridge, in which the diagnosis was doubtful. Dr. Bridge had had the patient under treatment for eleven days as a case of atypical typhoid. Dr. Billings was called in to see the case, and considered it one of interstitial hepatitis, probably a pylephlebitis. There was a sudden exacerbation of an alarming character in the symptoms of the patient, much resembling a typhoid hæmorrhage, with great shock, collapse, cold, flabby extremities, depleted blood-vessels. Dr. McArthur being called, was inclined to believe it to be a case of perforation from typhoid associated with typhoid hæmorrhage. The condition of the patient being desperate, a laparotomy was made. Perforation of a large vein in the mesentery of the cæcum was found, induced by a gangrenous appendix resting upon it. There was gangrene of the wall of that mesenteric vein and a severe hæmorrhage into the abdomen of a portal type. Post-mortem examination revealed a pylephlebitis which had occurred prior to the giving way of this wall, and the diagnosis of Dr. Billings was verified to that extent.

Again, in the practice of Dr. Frankenthal, the speaker saw a case of sudden fatal hæmorrhage as a result of a phlebitis incident to the resting of the appendix upon such a vein. Hæmorrhage was so severe as to cause death, and occurred through the abdominal wound, which was provided with a gauze drain, the blood escaping externally, but was so severe that before aid was given death ensued.

DR. MUNRO, in closing the discussion, said he had operated altogether on thirty-seven cases out of thirty-nine, but this did not include several cases he had seen in other men's work. There had been quite a number of such cases as he had described in his neighborhood. He recalled the case of a patient, ill for a number

of months, where a wrong diagnosis had been made, although it was a perfectly clear and straight case from the start of a typical appendicitis, with portal infection. It should have been recognized as such, but was not, and, what was most significant, at the autopsy the appendix was overlooked and not examined.

As to the infection that took place rapidly, both lymphatic and portal, the course might be extremely rapid, and simulating cases of fat necrosis at times. In one of his cases the lymphatic and portal infections were overwhelming, so that it was impossible to tell which was the more rapid. He believed that, in the long run, portal infections took place more rapidly than lymphatic, but not necessarily.

It was interesting, in going over the autopsies of cases reported twenty to forty years ago, to see that the three types were more or less grouped together, and, although there might have been cases in which portal infection predominated, yet careful autopsy would show that the lymphatics were often infected as well.

As to Dr. McArthur's case of biliary fistula, he had never seen a fistula persist as long as that without the patient dying. He thought his case was probably infected through the lymphatics. One of the speaker's recent cases of this type recovered. He was sure from his observation that lymphatic gland infections would remain dormant for months at a time, and then wake up, so to speak, and prove serious or fatal. Hæmorrhage from the veins he had not seen recorded.

EXCISIONS OF LIVER TISSUE.

DR. JACOB FRANK reported eighteen experiments on dogs. Two consisted of simply incising the liver through its entire thickness, without any suturing or other attempt to control hæmorrhage. Both dogs recovered. In the remaining sixteen experiments he pursued the following plan: When a portion of liver was to be removed in a transverse direction, a wedge-shaped piece was removed transversely to the viscus, leaving the organ with two flaps forming a trough. The flaps were then quickly coapted, and with a long, non-cutting needle, threaded with a medium heavy catgut, a continuous suture was taken, the sutures alternating, one carried through the liver tissue near the bottom

of the trough, and one superficially, until there was complete closure. It required very slight tension to approximate the flaps. The main object was to bring the flaps together obliterating all dead space. When a portion of liver was to be removed in a longitudinal direction to the viscus, a wedge-shaped piece of the entire thickness of the liver was cut out longitudinally, thus removing the desired part. The broad, raw surfaces left by the removal of the wedge-shaped portion was converted into troughs, which was accomplished by the excision of wedge-shaped pieces. The troughs thus formed had two flaps. When the operation was completed, the raw surfaces of the original V left were transformed into smooth, continuous liver tissue, assuming the form of liver borders, and the V space left persisting as a notch.

This method of incising the liver facilitated easy suturing and did not require any tension on the suture to coaptate the flaps. Hæmorrhage was successfully arrested, and the continuity of liver surface re-established. No drainage was used in any of the experiments.

DR. JOHN C. MUNRO said that the ordinary V-shaped incision had proven sufficient in a number of instances in which he had sutured the liver, using coarse catgut. In bringing the edges of the wound together, it was best to have an assistant make pressure on the liver itself with his hands, bringing the flaps together, before placing the sutures. They could then be tied, without the liability of their cutting through.

DR. WILLIAM E. SCHROEDER stated that a year and a half ago he removed a third of the right lobe of the liver for primary abscess, and used a long needle with mattress sutures for suturing the liver tissue, with which he was able to control hæmorrhage nicely. The patient made an uninterrupted recovery.

DR. L. L. MCARTHUR had had two cases in which he had sutured the liver, one requiring the removal of a wedge-shaped piece of the under surface of the liver. In this case tamponing was quite sufficient to control the hæmorrhage. In the other case the tumor was situated under the ensiform cartilage; the patient was transferred to the surgical service of the hospital as a probable aneurism of the aorta. Bruit and pulsation were present and vomiting distressed the patient. A laparotomy was made. A diagnosis was made of possible tumor of the liver pressing on the stomach and producing vomiting. This was found to be true, and

search for the primary source of the trouble in the stomach or gall-bladder failed to reveal primary carcinoma there. A carcinoma of the left lobe of the liver as large as an orange was removed by means of a wedge-shaped incision. Tamponing was resorted to for controlling hæmorrhage, which it did satisfactorily. The patient recovered, so far as the removal of the tumor was concerned, but died later of carcinoma of the lesser curvature of the stomach, which was so small as to have been overlooked. Where large wedge-shaped pieces are removed from the liver, the speaker thought that patients would fail to have an exit for the bile, and that therefore leakage would occur. The patient mentioned had a permanent biliary fistula, and died from carcinoma of the stomach. To control hæmorrhage in that way, he would expect a biliary fistula, if extensive wedge-shaped pieces of the liver were removed from the human being, with sequelæ later to be dealt with.

DR. FRANK, in closing the discussion, said his experience had been that, with a wedge-shaped piece taken out of the liver, it was almost impossible to bring the tissue together. It was certainly impossible to hold with suture the liver tissue long enough for it to unite, and this was one of the reasons that induced him to conduct the series of experiments he had detailed. He had cited cases in which tamponade was employed, as referred to by Dr. McArthur, and his experiments were conducted with a view of doing away with tamponing or packing. He thought the surgeon should deal with the liver as he would deal with a case of resection of the kidney or the removal of the uterus, closing the wound completely. In injuries of the liver there was usually bile leakage, which came on six, eight, or nine hours afterwards, and was it not possible, if one could bring the two surfaces in contact, to re-establish continuity? Then union would take place so rapidly that there would be no leakage of bile.

REVIEWS OF BOOKS.

THE MODERN MASTOID OPERATION. By FREDERICK WHITING, A.M., M.D. Royal Square Octavo. Philadelphia: P. Blakiston's Son & Co.

The author in his preface excludes, as beyond the scope of the present work, the technique of the radical operation for chronic otorrhœa, and the methods of procedure in sinus thrombosis, brain abscess, and other intracranial inflammatory processes, but promises a publication covering this field in the not distant future. He well says that "as a life-saving measure few surgical procedures rival and none surpass in efficiency the modern mastoid operation."

The first portion of the work is historical and is divided into three chapters: the first chapter describes the development of the operation for drilling the mastoid process. The second chapter treats of the operation devised by Schwartz, to whom just credit is given in the following words: "Schwartz executed, and consequently enjoys the undisputed distinction of having clearly enunciated, the technical and symptomatic principles upon which are based the steps of the modern mastoid operation as performed to-day." The author states that Gruening's modification of the Schwartz operation—the removal of the mastoid tip—"was the only essential departure from Schwartz's original steps which twenty years of continuous experience had dictated." The third chapter describes what the author calls "the complete mastoid operation," "because of its intent to remove the entire cellular structure of the mastoid apophysis." The author claims as the first point of difference the method of making the tegumentary incision. The incision pictured, however, is not original, being to all intents the well-known and previously described classical

incision with a horizontal limb at right angles on a level with the centre of the external auditory meatus. This incision, which has been in use for some time by various surgeons, exposes to view "the entire mastoid apophysis," "thus insuring a comprehensive view of the operative field." "The second difference, from the Schwartze operation, as modified by Gruening, is the removal of the pneumatic spaces and diploic cells at the posterior root of the zygoma." To the author, himself, the credit for this modification is largely due. The author claims that "in every instance where secondary operation has been required in his service the offending agents were found" in this region. Purulent accumulations in the posterior root of the zygoma "have . . . in several instances in the writer's experience caused erosions of the inner table, and been responsible for small epidural abscesses of the middle cranial fossa, while cortical perforations of the root of the zygoma, with accompanying subperiosteal abscess, are by no means so infrequent as to excite special interest." "The thorough removal of the zygomatic cells in conjunction with a similar treatment of the mastoid tip has proved in the hands of the writer an unequivocal success, and he earnestly commends the procedure as a method calculated, when conscientiously pursued, to produce a satisfactory result in every instance:" this certainly is a strong claim if substantiated by time and experience, and the author has warrant in the latter. He regards "the complete mastoid operation as a positive assurance of successful healing and an infallible safeguard against the vexations and annoyances of secondary operation."

Chapter IV is concerned with the pathology of suppurative mastoiditis, and is so well written, so illuminating, and so much to the point, that any attempt to convey an adequate idea of its excellences would do the author an injustice: it should be read in the original.

The preliminary preparations for operation constitute the subject matter of Chapter V.

Chapter VI describes the tegumentary incisions.

Chapter VII is concerned with the elevation of the periosteum and the retraction and reflection of the flaps.

Chapters VIII, IX, and X describe the various stages of the attack on the bone up to the exposure and clearing out of the antrum. The author gouges out a groove beginning in the supra-meatal triangle at the centre of the suprameatal spine and extending thence downward to the tip, keeping the posterior margin of the bony meatus in view and hugging it tightly; this groove is deepened until the cellular structure is reached, when the curette or Volkmann spoon is utilized to undermine the cortical bone. In infants and young children, the curette is used to make the initial groove and the entire opening in the mastoid bone. The bone wound is widened by making grooves parallel to the initial one in the cortex and removing the cellular structures with the curette, further advance being assisted by the use of the rongeur. After the antrum is opened, "the walls enclosing this space should then be removed until no overhanging borders remain": "the opening of the antrum is the step of fundamental importance." The author recommends that the operator "desist from using the chisel, and employ the curette and rongeur at the earliest moment possible."

The removal of the mastoid tip and of the cortex and cells overlying the sigmoid groove are described in Chapters XI and XII.

The author, in Chapter XIII, gives his reasons for and describes his method of removing the cells at the posterior root of the zygoma. These cells lie "just in front of and external to the antrum" and "are nearly always occupied in front of and external to the antrum" and "rare nearly always occupied by necrotic granulations when purulent mastoiditis has existed for any length of time." "The diploic structures in contact with the sigmoid groove and the overlying subcortical cells as far back as the posterior border of the groove should be curetted

until the inner table is smooth." "The rough and irregular margin of the entire opening in the mastoid process should be carefully smoothed with the ronguer and curette." The inflammatory process may be confined in exceptional cases to the region in and about the zygomatic cells. "With the removal of this portion of the mastoid, the last structures which are liable to die as the result of purulent mastoiditis disappear." "An operator will be certain of his result . . . only when all cellular structures have been removed." In smoothing the bone surface, "the curette should be held so that the cutting edge lies as nearly as possible horizontal with the surface which it is intended to smooth." "Surfaces which have thus been rendered smooth granulate much more rapidly and evenly and heal more quickly."

The author, in Chapters XIV, XV, and XVI deals with the closure, dressing, and after-care of the wound.

Chapter XVII covers the indications for the mastoid operation, with differential diagnosis. The author states that "deafness, subjective noises, fulness, and kindred sensations are of no material importance, and are entirely devoid of any significance;" the reviewer agrees with Sheppard, who attaches *considerable confirmatory significance* to the presence of persistent, well-marked throbbing tinnitus. "Deep boring pain which grows worse at night . . . must always be regarded as decidedly significant." The author rightly draws attention to "a symptom which is not always present, but which, when it exists, is entitled to consideration, decided prostration, or an indisposition for exertion or effort." Bulging of the superior posterior membranous canal wall "may be regarded as the most definite and pronounced of all fundus symptoms of mastoiditis." "The only distinct evidence of mastoiditis" which the tympanic membrane affords is a pronounced bulging. "Tenderness of the mastoid bone is justly and universally regarded as the one indication distinctly characteristic of mastoid disease:" "but negative testimony is unfortunately by no means conclusive evidence that the pneumatic

structures of the mastoid do not contain pus." The writer urges "that resort should be had to operative measures at the earliest moment when, in the presence of suppuration from the ear, a majority of the symptoms enumerated are to be recognized."

The book is a veritable triumph of the book-maker's art, handsomely bound, beautifully printed on heavy paper, and with most excellent plates. The reviewer has not in a long time enjoyed such a treat as in reading this most entertainingly written book. But this very excellence in the production of the book as such is also somewhat open to criticism, for it has involved a certain sacrifice in convenience, as the book is thereby made somewhat heavy and unwieldy, and the cost of production has necessitated the imposition of a selling price which must prove quite a tax upon those who will mainly be benefited by the reading of it, *i.e.*, the beginners in the otological field.

HENRY A. ALDERTON.

INTERNATIONAL CLINICS. Edited by A. O. J. KELLY, A.M., M.D.
Vols. I and II, 1905. Philadelphia: J. B. Lippincott Company, 1905.

Vol. I of these excellent publications contains, besides articles on the general and other special subjects of medicine, a number of chapters dealing with surgical subjects of timely value. Among these chapters is one on skin-grafting in the treatment of the large ulcers following burns. This chapter presents some modifications of the methods in use, and reports a series of cases showing some excellent results. Another interesting chapter is on the starvation of malignant growths by depriving them of blood supply. A new operative method for the total extirpation of the larynx is described. The final two surgical chapters are upon the treatment of knee-joint disease, and the treatment of Glenard's disease

Vol. II contains chapters on lateral curvature of the spine; chronic arthritis; tuberculous spondylitis and coxitis; nerve

anastomosis for the cure of infantile palsy; the operative treatment of constipation; gastric surgery; the symptomatology and diagnosis of Glenard's disease; and post-climacteric hæmorrhages. All of these chapters present material of modern interest.

One of the most important and valuable features of the first volume is a *résumé* of the progress of medicine during the past year. All subjects which are attracting present-day interest, and which have been discussed in current medical literature, are presented briefly in the light of whatever new knowledge has been brought to bear upon them.

J. P. WARBASSE.

CORRESPONDENCE.

EDITOR ANNALS OF SURGERY:

MY paper on "Scopolamine-Morphine Anæsthesia" in the August issue contains a serious error. It gives the dose of scopolamine as "one-tenth milligramme," whereas it ought to be "one milligramme."

EMIL RIES.